



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
OFFICE OF PREVENTION, PESTICIDES, AND TOXIC SUBSTANCES  
WASHINGTON, D.C. 20460

August 26, 1999

**MEMORANDUM**

**SUBJECT:** The revised Occupational and Residential Exposure aspects of the HED Chapter of the Reregistration Eligibility Decision Document (RED) for Terbufos, Case #838564, PC Code 059201, DP Barcode D258665

**From:** Jeffrey L. Dawson, Chemist  
Reregistration Branch I  
Health Effects Division 7509C

**Thru:** Whang Phang, Ph.D., Branch Senior Scientist  
Reregistration Branch I  
Health Effect Division 7509C

**To:** William Hazel, Ph.D., Chemist  
Reregistration Branch I  
Health Effect Division 7509C

The purpose of this revision to the occupational and residential risk assessment for terbufos is to incorporate recently submitted data to the Agency. The data, submitted by the registrants (American Cyanamid), include two dermal toxicity studies specific to each available granular formulation, two worker exposure studies that evaluated the application of each available formulation, and a handler exposure/risk assessment.

The following labels (identified by EPA Reg. No.) served as the basis for this assessment: 241-241; 241-238; 241-314; NC92000100; and NC 92000200.

The exposure scenarios based on the use patterns in the section 24 C (SLN) labels are essentially reflected in the assessments completed for the labels listed above (i.e., applications to sweet corn). As such, the only additional consideration in this assessment for the SLN labels was to include the application rate in the assessment for those uses.

# Executive Summary

Terbufos (S-[[[(1,1-Dimethylethyl)thio]methyl] 0,0-diethyl phosphorodithioate), is an organophosphate insecticide that is marketed in granular products intended for use in agriculture. The granular terbufos formulations that are available include a clay-based 15G and a polymer-based 20CR granule. The 15G is marketed only in “Lock-N-Load” closed systems while the 20CR is sold in bags and also in “Lock-N-Load” closed systems. Terbufos is used to control a variety of pests in corn, sugar beets, and sorghum. It is typically applied at-planting with concurrent soil incorporation with ground based application equipment (i.e., row planters) but can also be applied post-emergence or during cultivation activities.

The exposures considered in this risk assessment by the Agency are for the occupational handlers (those involved in the agricultural application) of terbufos. The Agency did not quantitatively consider exposures to terbufos after application because of the manner in which it is applied (i.e., soil incorporation and lack of early season activities minimize the potential for exposure). No terbufos products are intended for sale that homeowners or professional applicators can use in a residential environment. The Agency also believes that the potential for off-target migration of terbufos during agricultural applications is minimal. Therefore, no residential exposure/risk assessment has been completed.

The Agency risk assessment for terbufos has been significantly revised because the registrant has submitted two formulation-specific dermal toxicity studies and also two chemical- and scenario-specific exposure studies that have been used in the risk assessment (i.e., dermal toxicity studies on the 15G and 20CR formulations and exposure studies on the 15G in “Lock-N-Load” packaging with closed cab application and on the 20CR in bags with open cab application). These exposure data represent the best source of data currently available to the Agency for completing an assessment for terbufos as the data are of high quality and are intended to be specific for the scenarios being considered in this assessment. The chemical- and scenario-specific data (for the 15G and 20 CR formulations) have not been integrated with the Pesticide Handlers Exposure Database (PHED) for a concurrent analysis because the Agency believes that there are physical differences in the formulations and packaging as well as the levels of personal protection evaluated in the study that preclude combining the data. They are also unique because they represent a slightly higher level of personal protection than is typically considered in the risk assessment process using PHED. Unit exposure values were calculated from each study representing the minimum and maximum monitored values as well as the geometric mean (which is a measure of central tendency of the data). The geometric mean value is the closest approximation of the unit exposure values commonly calculated by the Agency using PHED as the unit exposure values from PHED reflect the central tendency of the data.

The registrant used the 15G data to extrapolate to an open loading/open cab application exposure scenario in their submitted risk assessment. The Agency does not believe this is a valid approach given the reliance on unrefined protection factors and that empirical data exist in PHED for this scenario. As a result, the Agency used PHED to consider the open loading and open cab application exposure scenarios for the 15G. The Agency did use the 15G “Lock-N-Load” and closed cab data from the study to consider the 20CR formulation in closed systems and/or closed cab applications.

When the geometric mean values from the chemical- and scenario-specific exposure studies serve as the basis of the assessment, the Agency has no concerns over the use of terbufos 15G in

“Lock-N-Load” packaging and application with closed cabs (with the same levels of personal protective equipment used in the study) if respirators are also used. The Agency has some concerns over the use of the 20CR formulation of terbufos in open bags and with open cab application for loaders and combined loader/applicators in the higher usage scenarios (i.e., the lowest MOE for these higher use rate scenarios >60). However, if the 15G study data are used as a surrogate, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with closed cab application if a respirator is used because the risks are of no concern for the 15G in the same scenario, the inhalation NOAEL is the same, and the dermal NOAEL (2.0 mg/kg/day) for the 20CR formulation is 6.25 times higher than the NOAEL (0.32 mg/kg/day) for the 15G formulation. Likewise, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with open cab application (i.e., based on combination of 15G and 20CR study data) if a respirator is used .

In all cases, where the Agency has risk concerns, the predominant contributor (i.e., driver) to the overall or total risk is the inhalation component. This conclusion is supported by the fact that MOEs far exceed 100 based on either the geometric mean or maximum dermal exposure values from the chemical- and scenario-specific data. The large percentage of samples in this study that did not contain detectable terbufos residues should also be considered keeping in mind that the exposure studies are examples of the current state-of-the art and that the analytical aspects of the study are high quality (i.e., the LOD & LOQ values for each sample media are very low yet yield consistent results).

The analysis completed using PHED data supports the results of the risk assessment completed using the chemical- and scenario-specific data because it was completed at lower levels of personal protection indicating a need for the exposure data collected in the two monitoring studies at a higher level of personal protection. In some cases, the Agency has no concerns from dermal exposure at levels of personal protection that are lower than those used in the monitoring studies (i.e., maximum PPE or engineering controls). However, the Agency has concerns for all scenarios when inhalation exposures or combined exposures (inhalation and dermal) are considered. The Agency recommends that the PHED assessment be used for risk characterization purposes given the chemical- and scenario-specific nature of the recently submitted data.

To summarize, the chemical- and scenario-specific exposure and toxicity data indicate that terbufos formulated as a 15G clay-based granule used with “Lock-N-Load” closed loading systems and concurrent closed cab application presents no risk concern. This is also based on the premise that users wear/use the same levels of personal protective equipment as used in the study and a respirator. Terbufos formulated as a 20CR polymeric granule used with “Lock-N-Load” closed systems and either open cab applications or concurrent closed cab applications presents no risk concerns. These scenarios are different than the scenarios monitored in the 20CR exposure study. The Agency does have concerns over open bag loading of the 20CR. Inhalation risks are the predominant contributor to the overall risks in this case.

## 1. Background Information

This memo was developed based on previous versions of the terbufos risk assessment and other information contained in the following documents:

- *United States Environmental Protection Agency, Guidelines for Exposure Assessment*; Federal Register Volume 57, Number 104 (Friday May 29, 1992).
- *United States Environmental Protection Agency, Draft Standard Operating Procedures (SOPs) For Residential Exposure Assessment* (December 11, 1997).
- *United States Environmental Protection Agency, Series 875 - Occupational and Residential Exposure Test Guidelines, Group B - Postapplication Exposure Monitoring Test Guidelines*; Version 5.4; (February 10, 1998).
- *United States Environmental Protection Agency, Pesticide Handlers Exposure Database*, Version 1.1; (1993).
- *United States Environmental Protection Agency, Exposure Factors Handbook*, EPA Report 600/P-95/002Fa, August, 1997.
- August, 1999 EPA HIARC report for terbufos.
- *Terbufos: Revised Risk Assessment*; (3/4/99) Chemical ID No. 105001, Case 0109, DP Barcode D253850, From William Hazel (OPP/HED/RRB-1) to Pamela Noyes and Robert McNally (OPP/SRRD).
- Various Correspondence From American Cyanamid to the EPA (letters dated June 23, 1999; August 20, 1998; October 12, 1998; and January 15, 1999). Authored by Mark Galley, Director U.S. Plant Regulatory Affairs or John Wrubel, Product Registrations Manager, U.S. Plant Regulatory Affairs.
- *Occupational And Residential Exposure Assessment And Recommendations For The Reregistration Eligibility Document For Terbufos*; (May 18, 1995) Chemical ID No. 105001, Case 0109, DP Barcode D192404, From Alan P. Nielsen (OPP/HED/OREB) to Karen Whitby (OPP/HED/RCAB).
- *Current ORE Issues Related To Terbufos (Chem # 105001) RED Status*; (March 4, 1998), DP Barcode D241134 and D243778 From Jeff Dawson (OPP/HED/RRB-1) to William Hazel (OPP/HED/RRB-1).
- *Use and Usage Information*; (7/15/99) sent by email by John Wrubel (Product Review Manager, American Cyanamid) to Jeff Dawson U.S. EPA (OPP/HED/RRB-1) with cc. to EPA CRM and U.S.D.A.

- *Quantitative Usage Analysis*; (July, 1999) completed by Dhol Herzi (EPA/OPP/BEAD).
- *Final Usage Analysis For Terbufos RED*; (2/8/99) From Donald Atwood and Kathy Davis (OPP/BEAD) to Pamela Noyes (OPP/SRRD).
- *Occupational Exposure and Risk Assessment For Loaders and Applicators Handling Terbufos Products and Supporting Worker Exposure Studies*; (3/26/99) Authored by Joseph Higham, Richard Honeycutt, D. Larry Merricks, Rose A. Sweeney, Cassi L. Walls, and Susan H Youngren; Completed by ABC Laboratories of Columbia MO, HERAC of Greensboro NC, Agrisearch of Frederick MD, Novigen Sciences of Washington DC, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 1 of EPA MRID 447933-01, Terbufos 99-02, EXA 99-004, EXA 99-006, and RES 99-003, Sponsored by American Cyanamid.
- *Exposure of Farmworkers To Terbufos (CL 92100) While Loading COUNTER 15G Systemic Insecticide-Nematicide With A Lock-N-Load Closed Handling System And Applying COUNTER 15G To Corn At Planting Time*; (3/26/99) Authored by Joseph Higham; Completed by ABC Laboratories of Columbia MO, Agrisearch of Frederick MD, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 2 of EPA MRID 447933-01, Terbufos 99-02, EXA 99-004, EXA 99-006, and RES 99-003, Sponsored by American Cyanamid.
- *Exposure of Farmworkers To Terbufos (CL 92100) While Loading COUNTER CR Systemic Insecticide-Nematicide From A Bag And Applying COUNTER CR To Corn At Planting Time*; (3/26/99) Authored by Joseph Higham; Completed by ABC Laboratories of Columbia MO, HERAC of Greensboro NC, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 3 of EPA MRID 447933-01, Terbufos 99-02, EXA 99-004, EXA 99-006, and RES 99-003, Sponsored by American Cyanamid.
- *CL92100 (terbufos): Validation of GC/FPD Determinative Methods M3153, M3154, M3155, and M 3156 For The Determination of CL 92100 Residues In, Respectively, Whole Body Dosimeters, Aerosol OT Handwash and Glove Wash Solutions, Air Sampling Tubes and Face/Neck Wipes*; (3/26/99) Authored by Joseph Higham, Jill Cooper, and Rose Sweeney; Completed by ABC Laboratories of Columbia MO, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 4 of EPA MRID 447933-01, ABC Report 44703, and RES 99-003, Sponsored by American Cyanamid.
- *Terbufos Updated Risk Assessment USDA Comments*; (June 25, 1999) Forwarded by Therese Murtaugh of USDA.
- *Terbufos (AC 92100) - Response To Registrant's Rebuttal Regarding Reference Dose; Dust Generation/Characterization Studies*; (July 5, 1996) Authored by Alan C. Levy (OPP/HED/Tox-II) to William Hazel and Christina Swartz (OPP/HED/RCAB). Provides cursory review of study entitled Counter CR and Counter 15G, Dust Generation and Characterization by V Arendt (completed on 2/16/96, ID F-1356, submitted on 5/23/96).

The recent submission of the 21 day dermal toxicity and worker exposure studies has significantly altered the structure of the risk assessment for terbufos. In effect, all calculations included in this assessment have been revised to reflect the recent data submission and updated toxicology considerations. Specifically, the major revisions and modifications completed by the Agency in this document that differ from the previous risk assessment include:

- Short- and intermediate-term risks from dermal exposures to terbufos were calculated using the endpoints from two recently submitted 21 day dermal toxicity studies in rats and two recently submitted exposure monitoring studies. Terbufos is formulated as a clay-based granular formulation (15G) and as a polymeric granular (20 CR) that is more stable than the clay-based formulation. The dermal toxicity studies were completed using each granular formulation as were the exposure monitoring studies. The NOAEL (No Observed Adverse Effect Level) observed in the study for the 15G is 0.32 mg/kg/day while the NOAEL observed in the study for the 20CR is 2.0 mg/kg/day. These values have been determined to be appropriate for both short- and intermediate-term durations of exposure. The Agency believes that both short- and intermediate-term exposures can occur. Chronic or long-term exposures are not expected to occur with terbufos. The calculations completed in this assessment are different from the calculations completed in previous risk assessments for terbufos because the previous assessments were based on the use of an oral administration endpoint and a dermal absorption factor.
- Inhalation risks in this assessment were calculated using a route-specific inhalation administration study using rats. The NOAEL concentration in this study was 0.00001 mg/L which equates to a dose of 0.0035 mg/kg/day. This value have been determined to be appropriate for both short- and intermediate-term durations of exposure. The Agency believes that both short- and intermediate-term exposures can occur. Chronic or long-term exposures are not expected to occur with terbufos.
- Inconsistencies in unit exposure values and exposure scenarios noted in the previous risk assessment for handlers, were corrected. Risk assessments typically consider handler exposures using three different levels of personal protection including: baseline (applicators wearing long-pants and long-sleeved shirt); using maximum PPE (applicators at baseline with coveralls, gloves, and a respirator); and with the use of engineering controls (e.g., closed cabs, etc.). In this assessment, additional levels of personal protection were considered to reflect the data generated in the two granular exposure studies. Terbufos labels typically require the use of long-pants, long-sleeved shirts, coveralls, chemical-resistant gloves, protective eyewear, chemical-resistant headgear, and respiratory protection (PF 10 APR with a protection factor of 10 -- organic vapor removing cartridge with a prefilter). The studies, in addition, use engineering controls as an added measure of personal protection.

## **2. OCCUPATIONAL AND RESIDENTIAL EXPOSURE/RISK ASSESSMENT AND CHARACTERIZATION**

This document addresses the non-dietary exposures and risks associated with the use of the organophosphate insecticide, terbufos. Typically, these exposures can occur as a result of applying a chemical or by entering areas that have been previously treated. This chapter does not address possible terbufos exposures that occur through dietary intake of foods and water. Non-dietary exposures are categorized by the Agency based on whether or not they occur as part of a job (i.e., referred to as occupational or residential exposures) and based on if they occur during application or after application (i.e., handler or post-application exposures). Terbufos is used in a manner that precludes significant exposures to any residential population and also in a manner that minimizes the potential for post-application occupational exposures. Therefore, the only quantitative risk assessment that has been completed in this document is for occupational handlers.

*Risk* is defined in the *U.S. EPA Guidelines for Exposure Assessment* (U.S. EPA, Federal Register Volume 57, Number 104, Friday May 29, 1992) as the probability of deleterious health or environmental effects. *Risk assessment* can be described as the process that defines the *risk*. The *risk assessment* process has four major components including: exposure assessment, hazard identification, evaluation of the dose response, and characterization of the calculated risk values. This document address the exposure assessment and risk characterization aspects of the process. The hazard identification and evaluation of dose response are addressed in separate documents.

Use patterns and available products are summarized in a manner appropriate for nondietary risk assessment in *Section 2a: Use Pattern and Available Product Summary For Exposure Assessment*. The exposure/risk assessments that have been completed for each handler scenario are included in *Section 2b: Occupational and Residential Exposure/Risk Assessment*. The characterization issues associated with, and a summary of the results of each assessment, are included in *Section 2c: Occupational and Residential Risk Characterization*.

### **a. Use Pattern and Available Product Summary For Exposure Assessment**

Terbufos products are described in this section. Additionally, available information that describes the manner in which terbufos products are applied is provided in this section (e.g., use categories/sites, application methods, and application rates). This section specifically includes a description of the available products that contain terbufos (*Section 2.a.i: Manufacturing- and End-Use Products*); the mode of action of terbufos and the pests that it is labeled to control (*Section 2.a.ii: Mode of Action and Targets Controlled*); a description of the crops/groupings and other areas on which terbufos can be used (*Section 2.a.iii: Registered Use Categories and Sites*); and a description of the manner in which terbufos can be applied (*Section 2.a.iv: Application Parameters*). Deleted uses are no longer be considered in this assessment.

#### ***i. Manufacturing- and End-Use Products***

Terbufos (S-[[[(1,1-Dimethylethyl)thio]methyl] 0,0-diethyl phosphorodithioate), is an organophosphate insecticide that is marketed only in granular products intended for use in agriculture. The granular terbufos formulations that are available include a clay-based 15G and a polymer-based granule that contains 20 percent active ingredient. Based on a review (8/10/99) of the *Office of*

*Pesticide Programs -- Reference Files System (REFS)*, there are 5 active product labels. The distribution of these labels is as follows: 1 technical products, 2 Section 3 labels for end-use products, and 2 State and Local Need (SLN or 24C) labels. The following table summarizes all active Section 3 labels (SLN labels are not summarized for clarity and because they contain use patterns that are already reflected in the assessment for the Section 3 labels as previously noted):

Formulation Type	Percent Active Ingredient	EPA Reg. Numbers
Technical Grade	94	241-241
G (clay-based granule)	15	241-238
CR (polymer-based granule)	20	241-314

Terbufos products are only marketed for occupational use. There are no homeowner or residential use products. Additionally, no products are intended for use in residential settings by commercial applicators. Terbufos is a restricted use pesticide. The available products are intended only for use in the agricultural production of grain (i.e., corn and sorghum) and sugar beets. Based on information provided by the registrant, American Cyanamid, it appears that the 15G formulation is currently being sold only in closed loading systems (i.e., “Lock-N-Load”). The 20CR formulation is sold in both open containers (i.e., bags) and in closed loading systems (i.e., “Lock-N-Load”). Approximately 70 percent of 20CR sales is in the closed, “Lock-N-Load” systems.

#### ***ii. Mode of Action and Targets Controlled***

Terbufos is an organophosphate insecticide used for the control of many types of pests including:

- **On Corn:** corn rootworm, European core borers, wireworms, white grubs, seedcorn maggots, seedcorn beetles, corn flea beetles, maize billbugs, southern corn billbugs, thrips, chinch bugs, symphylans, nematodes, cutworms and cornstalk borers;
- **On Sorghum:** greenbugs, corn rootworms (incl. Southern corn rootworms), wireworms, white grubs, nematodes, chinchbugs and corn leaf aphids; and
- **On Sugar Beets:** sugar beet root maggot, sugar beet leafhopper, aphids, wireworms, white grubs, cutworms, sugar beet cyst nematodes, and beet leafhopper.

#### ***iii. Registered Use Categories and Sites***

An analysis of current terbufos uses was completed using available labels, the *Office of Pesticide Programs -- Label Use Information System, REFS*, and the recent *Quantitative Usage Analysis*. For reasons of clarity in Agency risk assessments, use patterns are generally described in a

manner that delineates the occupational from homeowner uses of terbufos. However, terbufos is registered for use by certified applicators only to treat corn, sorghum, and sugar beets so this delineation is not required.

#### *iv. Application Parameters*

*Application Parameters* is a generic term that describes the factors that are considered in the development of a risk assessment in relation to how a chemical is applied, how much is applied, and how often it is applied. These parameters are generally defined by the physical nature of the use site, how a product is formulated (e.g., form and packaging), by the equipment used to make the application, and by the application rate required by the label. Terbufos is a broadspectrum insecticide formulated as granular products that is used only in agriculture. Therefore, the application parameters are limited. The application parameters are presented below for each major specific crop/target (e.g., application rates and the equipment that can be used to make applications are included).

- **Corn:** Terbufos use in corn is generally part of an Integrated Pest Management (IPM) program. The IPM control strategy for these pests includes crop rotation, rapid seedling establishment and early planting, scouting, and insecticide application (at-plant and post-emergent). Field corn applications account for approximately 87.7 percent of all terbufos use while sweet corn applications account for < 1 percent of all terbufos use. The percent crop treated for field corn ranges from an average of about 8 percent to a maximum of 10 percent. The percent crop treated for sweet corn ranges from an average of about 5 percent to a maximum of 6 percent. Applications can be made at-planting, post-emergent, and during cultivation. All applications require soil incorporation. Terbufos is limited to one application per crop per year with 90 percent of the applications occurring at planting. The maximum application rate for all types of applications is 1.3 lb ai/acre regardless of the granular formulation used (i.e., 20CR or 15G). A SLN label also exists in North Carolina that allows for applications up to 2.6 lb ai/acre. This rate is also included in the assessment. Typical application rates range from approximately 1.1 lb ai/acre for field corn to 1.3 lb ai/acre for sweet corn. [Note: Information on typical application rates are not available. For the purposes of this risk assessment, the annual average application rate has been used to substitute for typical application rate information.] Application equipment includes granular row planters. This summary is based on the revised QUA (Quantitative Usage Analysis) of July 1999, information provided by the registrant, the 1999 usage analysis completed by D. Atwood and K. Davis of the U.S. EPA, and the following labels: 241-314 and 241-238.
- **Sorghum:** Applications account for approximately 2.6 percent of all terbufos use. The percent crop treated ranges from an average of about 2 percent to a maximum of 4 percent. Applications can be made at-bedding or at-planting with at-planting being the typical timing of application. All applications require soil incorporation. Terbufos is limited to one application per crop per year. The maximum application rate for all types of applications is 1.96 lb ai/acre regardless of the granular formulation used (i.e., 20CR or 15G). The typical application rate is 0.7 lb ai/acre. [Note: Information on typical application rates are not available. For the purposes of this risk assessment, the annual average application rate has

been used to substitute for typical application rate information.] Application equipment includes granular row planters. This summary is based on the revised QUA (Quantitative Usage Analysis) of July 1999, information provided by the registrant, the 1999 usage analysis completed by D. Atwood and K. Davis of the U.S. EPA, and the following labels: 241-314 and 241-238.

- **Sugar Beets:** Applications account for approximately 9.0 percent of all terbufos use. The percent crop treated ranges from an average of about 35 percent to a maximum of 43 percent. Applications can be made at-planting or as a post-emergent with at-planting being the typical timing of application. All applications require soil incorporation. Terbufos is limited to one application per crop per year. The maximum application rate for all types of applications is 1.96 lb ai/acre regardless of the granular formulation used (i.e., 20CR or 15G). The typical application rate is 1.3 lb ai/acre. [Note: Information on typical application rates are not available. For the purposes of this risk assessment, the annual average application rate has been used to substitute for typical application rate information.] Application equipment includes granular row planters. This summary is based on the revised QUA (Quantitative Usage Analysis) of July 1999, information provided by the registrant, the 1999 usage analysis completed by D. Atwood and K. Davis of the U.S. EPA, and the following labels: 241-314 and 241-238.

#### **b. Occupational and Residential Exposure/Risk Assessment**

The Agency has determined that there is a potential for occupational exposure from handling terbufos products during the application process (i.e., mixer/loaders and applicators). The Agency does not have significant concerns for occupational post-application exposure scenarios or for residential exposures because terbufos can be used only in agricultural areas and due to the manner in which it is applied (i.e., granulars requiring soil incorporation). As a result, a quantitative risk assessment has been completed only for various occupational handler scenarios. The exposure and risk assessments that have been completed are described in this section. All risks assessments are structured based on the toxicity of the chemical being considered. The toxicological endpoints that have been selected for terbufos are described in *Section 2.b.i: Toxicity Endpoints Used in the Exposure/Risk Assessment*. A description of the occupational handler exposure scenarios that serve as the basis for this assessment are presented in *Section 2.b.ii: Handler Exposure Scenarios* keeping in mind that there are no residential uses for terbufos. The mechanics of how the handler risk assessment was completed and the data used in that assessment are presented in *Section 2.b.iii: Handler Exposure and Risk Assessment*. The rationale for not completing a quantitative post-application assessment is presented in *Section 2.b.iv: Post-Application Exposure Scenarios*.

##### ***i. Toxicity Endpoints Used in the Exposure/Risk Assessment***

A series of toxicological endpoints were used to complete the risk assessment. The endpoints that were used to complete this assessment are summarized below (by applicable route and duration) in order to provide a quick reference to the risk assessments. The toxic effect associated with all noncancer terbufos endpoints is red blood cell and plasma cholinesterase inhibition. Dermal toxicity studies (28 day duration) were completed using the granular end-use-products (15G and 20CR). These studies were selected as the basis for risk assessment for each specific product. No endpoint for

a cancer risk assessment has been selected.

- **For the 15G, Short- and Intermediate-Term Dermal:** 0.32 mg/kg/day based on a NOAEL from a 28 dermal toxicity study in rats. [Note: The NOAEL presented here is the concentration of the active ingredient and not the formulated product which was tested. The amount of active ingredient dose from the amount of formulated product tested has been calculated based on the concentration in the product.];
- **For the 20CR, Short- and Intermediate-Term Dermal:** 2.0 mg/kg/day based on a NOAEL from a 28 dermal toxicity study in rats. [Note: The NOAEL presented here is the concentration of the active ingredient and not the formulated product which was tested. The amount of active ingredient dose from the amount of formulated product tested has been calculated based on the concentration in the product.];
- **For any formulation, Short- and Intermediate-Term Inhalation:** 0.0035 mg/kg/day based on a NOAEL from a subchronic inhalation toxicity study in Sprague Dawley rats of both sexes. [Note: Calculated, based on Whalan *et al.*, as follows:  $0.00001 \text{ mg/L} * 100\% \text{ Absorption} * 43.5 \text{ L/hr/kg for rat strain} * 8 \text{ hours duration} * 1 \text{ Activity Factor} = 0.0035 \text{ mg/kg/day}$ .]
- **Dermal Absorption:** Not required since dermal toxicity studies used for assessment;
- **Uncertainty Factors Applied to Occupational Assessments:** 100 for both short-term and intermediate-term scenarios.

[Note: No long-term or chronic exposures for terbufos are anticipated because of the way it is used in agriculture. Additionally, the endpoints selected for the dermal and inhalation exposure assessments have been applied to both short- and intermediate-term exposure scenarios.]

## *ii. Handler Exposure Scenarios*

Exposure scenarios can be thought of as ways of categorizing the kinds of exposures that occur related to the use of a chemical. The use of scenarios as a basis for exposure assessment is very common as described in the *U.S. EPA Guidelines For Exposure Assessment* (U.S. EPA; Federal Register Volume 57, Number 104; May 29, 1992). The purpose of this section is to describe the exposure scenarios that were used by the Agency in the assessment for terbufos handlers and to explain how the scenarios were defined. Information from the current labels; use and usage information; toxicology data; and exposure data were all key components in the developing the exposure scenarios.

The Agency uses the term “Handlers” to describe those individuals who are involved in the pesticide application process. The agency believes that there are distinct job functions or tasks related to applications and that exposures can vary depending on the specifics of each task. Job requirements

(e.g., amount of chemical to be used in an application), the kinds of equipment used, the crop or target being treated, and the circumstances of the user (e.g., the level of protection used by an applicator) can cause exposure levels to differ in a manner specific to each scenario.

The Agency uses a concept known as *unit exposure* as the basis for the scenarios used to assess handler exposures to pesticides. *Unit exposures* numerically represent the exposures one would receive related to an application, they are generally presented as (mg active ingredient exposure/pounds of active ingredient handled). The Agency has developed a series of unit exposures that are unique for each scenario typically considered in our assessments (i.e., there are different unit exposures for different types of application equipment; job functions; and levels of protection). The *unit exposure* concept has been established in the scientific literature and also through various exposure monitoring guidelines published by the U.S. EPA and international organizations such as Health Canada and OECD (Organization For Economic Cooperation and Development). The concept of unit exposures can be illustrated by the following example. If an individual makes an application using a groundboom sprayer with either 10 pounds of chemical A or 10 pounds of chemical B using the same application equipment and protective measures, the exposures to chemicals A and B would be similar. The unit exposure in both cases would be 1/10th of the total exposure (measured in milligrams) received during the application of either chemical A or chemical B (i.e., milligrams on the skin after applying 10 pounds of active ingredient divided by 10 pounds of active ingredient applied).

The first step in the handler risk assessment process is to identify the kinds of individuals that are likely to be exposed to terbufos during the application process. In order to do this in a consistent manner, the Agency has developed a series of general descriptions for tasks that are associated with pesticide applications. Common tasks (as an example) can include: preparation of dilute, water-based spray solutions for application; transferring or loading granular products into spreaders for application; and making applications with specific types of equipment such as groundboom sprayers or in-the-row planters commonly used to apply granulars at planting. The Agency also considers whether or not individuals use pesticides as part of their employment (referred to as occupational risk assessments) or if they are individuals who purchase and use pesticide products in and around their residences (referred to as homeowners). There are no homeowner uses for terbufos. As a result, only occupational scenarios are considered in this assessment. The tasks associated with terbufos use (i.e., for “handlers”) can generally be categorized using the following terms:

- **Occupational Mixer/loaders:** these individuals perform tasks in preparation for an application. For example, they would prepare dilute spray solutions and/or load/transfer solid materials (e.g., granulars such as Counter 15G or Counter 20CR) into application equipment such as a groundboom tractor or planter prior to application.
- **Occupational Applicators:** these individuals operate application equipment during the release of a pesticide product into the environment. These individuals can make applications using equipment such as groundboom sprayers or tractor-drawn spreaders for granular materials.

- **Occupational Mixer/loader/applicators:** these individuals are involved in the entire pesticide application process (i.e., they do all job functions related to a pesticide application event). These individuals would load a granular into a planter and then also complete an application. There are growers who would complete all aspects of an application event as opposed to events where individual people would complete the application. As such, risks have been calculated for these individuals.

There are individuals who use terbufos that fit into each of the job function categories described above. Therefore, the terbufos risk assessment for handlers contains exposure scenarios in each category.

The next step in the risk assessment process is to define what kinds of equipment, packaging, and formulation types (as well as other kinds of factors that can vary in specific assessments) can be used by individuals when making terbufos applications. In agriculture, terbufos can be used occupationally to treat corn, sorghum, and sugar beets. All applications of terbufos in agriculture involve granular formulations and soil incorporation. Terbufos 15G and 20CR are now both almost exclusively sold in “Lock-N-Load” packaging (15G is 100% and 20CR is approximately 70% of sales). The 20CR formulation is also sold in bags that allow for an open bag/loading exposure scenario. Terbufos labels suggest particular types of application equipment, in-the-row planters, for these crops as is common for most pesticides of this type (i.e., the label provides application settings for popular brandname planters, other planters can be used with calibration). Information supplied by the registrant indicates that 30 inch rows are common for corn and 20 inch rows are more typical for sorghum and sugar beets. The Agency expects that terbufos applications are routinely made with these kinds of equipment that are common in agriculture and has based the exposure/risk assessment on this premise.

Next, assessors must understand how exposures to terbufos occur (i.e., frequency and duration) and how the patterns of these occurrences can cause the effects of the chemical to differ (referred to as dose response). Wherever possible, use and usage data determine the appropriateness of certain types of risk assessments (i.e., a chronic risk assessment is not warranted for terbufos because chronic duration exposure patterns do not occur). Other parameters are also defined from use and usage data such as application rates and application frequency. The Agency always completes risk assessments using maximum application rates for each scenario because what is possible under the label (the legal means of controlling pesticide use) must be evaluated, for complete stewardship, in order to ensure there are no concerns for each specific use. Additionally, whenever the Agency has additional information such as typical application rates for some crops, as in this case, it uses the information to further evaluate the overall risks associated with the use of the chemical in order to allow for a more informed risk management decision. In this case, average application rates (considered to be the same as typical rates for the purposes of this assessment) defined in the recent *Quantitative Usage Analysis* were available for some crops and integrated into the assessment.

A chemical can produce different effects based on how long a person is exposed, how frequently exposures occur, and the level of exposure. It is likely that terbufos exposures can occur in a variety of patterns. The Agency believes that occupational terbufos exposures can occur over a single day or up to 6 weeks or so at a time even though each crop or application target is generally treated only once per season. Intermittent exposures over several weeks are also anticipated as a normal pattern of exposure. Some applicators may apply terbufos over a period of weeks because they

need to cover large acreage, they may be custom or professional applicators that are completing a number of applications within a region, or they may be applying terbufos over a period of several days. The Agency classifies exposures of one week or less as short-term exposures and exposures of 1 week to several months as intermediate-term exposures. The Agency completes both short- and intermediate-term assessments for occupational scenarios in essentially all cases because these kinds of exposures are likely and acceptable use and usage data are not available to justify deleting some intermediate-term assessments. For terbufos, the Agency has selected two sets of dermal endpoints because of concerns over how the physical nature of each formulated product can affect dermal toxicity. The Agency has only selected a single endpoint for inhalation exposure assessment to both granular formulations because only a single study was available using the active ingredient. Each endpoint is believed to be acceptable for all durations that encompass the short- and intermediate-term timeframes. Long-term or chronic exposures (essentially every working day over a year) can also occur for some chemicals. No long-term exposures are associated with the use of terbufos. These classifications are the basis for selecting toxicological endpoints for chemicals in each risk assessment. To summarize, the Agency has completed risk assessments for terbufos based on the duration of exposure and due to the mechanism of dermal toxicity for each granular formulation (i.e., 1 for 15 G short- and intermediate-term durations and 1 for 20 CR short- and intermediate-term durations).

The toxicity of chemicals can also vary based on the route of exposure or how a chemical enters the body. For example, exposures to the skin can result in a different toxic effect and/or severity of reaction than exposures via inhalation. The effects of a chemical can also vary for different durations of exposure. The toxicology database for terbufos indicates that the Agency needs to consider short- and intermediate-term exposures to the skin separately from exposures via inhalation because the effects and the dose levels at which effects occur differ based on whether it is deposited on the skin or it is inhaled (e.g., endpoints selected from 21 day dermal study and acute neurotoxicity study were used for the short-term risk assessment). Risks were also considered separately because the NOAELs from the dermal toxicity studies were different indicating that each formulation (15G or 20 CR) has a different dermal toxicity. The endpoints selected and how they are applied in the risk assessment has been previously presented above in *Section 2.b.i: Toxicity Endpoints Used in the Exposure/Risk Assessment*.

Occupational handler exposure assessments are completed by the Agency using different levels of personal protection. The Agency typically evaluates all exposures with minimal protection and then adds additional protective measures using a tiered approach to obtain an appropriate MOE or until all options are exhausted (i.e., going from minimal to maximum levels of protection). The lowest tier is represented by the baseline exposure scenario followed by increasing the levels of personal protection represented by personal protective equipment or PPE (e.g., gloves, extra clothing, and respirators) and engineering controls (e.g., closed cabs and closed loading systems). This approach is always used by the Agency in order to be able to define label language using a risk-based approach and not based on generic requirements for label language. In addition, the minimal level of adequate protection for a chemical is generally considered by the Agency to be the most practical option for risk reduction (i.e., over-burdensome risk mitigation measures are not considered a practical alternative for regulatory action). For terbufos, five distinct levels of dermal protection were considered in the assessment to account for the use of standard work clothing (long-pants and long-sleeved shirt), standard work clothing with a pair of chemical-resistant gloves, standard work clothing with a pair of chemical-resistant gloves and an additional layer of clothing such as coveralls, the use of engineering controls,

and the use of engineering controls in conjunction with personal protective equipment as measured in the chemical-specific exposure studies submitted for terbufos. Additionally, five levels of respiratory protection were considered in the assessment to account for no respiratory protection, the use of dust/mist PF 5 and air purifying PF 10 respirators (PF = protection factor), the use of engineering controls, and the use of engineering controls in conjunction with personal protective equipment as measured in the chemical-specific exposure studies submitted for terbufos. [Note: The manner in which these calculations have been completed allow for flexibility in determining final protective measures -- see Section 2.c for further details.] The levels of protection that formed the basis for the calculations in this assessment include:

- **Baseline:** Represents typical work clothing or a long-sleeved shirt and long pants with no respiratory protection. No chemical-resistant gloves are included in this scenario. [Note: This scenario used only for exposure data developed using the Pesticide Handlers Exposure Database -- see Section 2.b.iii for further information.]
- **Minimum Personal Protective Equipment (PPE):** Represents the baseline scenario with the use of chemical-resistant gloves and a dust/mist respirator with a protection factor of 5. [Note: This scenario used only for exposure data developed using the Pesticide Handlers Exposure Database -- see Section 2.b.iii for further information.]
- **Maximum Personal Protective Equipment (PPE):** Represents the baseline scenario with the use of an additional layer of clothing (e.g., a pair of coveralls), chemical-resistant gloves, and an air purifying respirator with a protection factor of 10. [Note: This scenario used only for exposure data developed using the Pesticide Handlers Exposure Database -- see Section 2.b.iii for further information.]
- **Engineering Controls:** Represents the use of an appropriate engineering control such as a closed tractor cab or closed loading system for granulars or liquids. Engineering controls are not applicable to handheld application methods there are no known devices that can be used to routinely lower the exposures for these methods. [Note: This scenario used only for exposure data developed using the Pesticide Handlers Exposure Database -- see Section 2.b.iii for further information.]
- **Engineering Controls and Personal Protective Equipment:** Represents the use of an appropriate engineering control such as a closed tractor cab or closed loading system for granulars along with additional layers of clothing and equipment (e.g., aprons and chemical-resistant gloves). [Note: This scenario used only for exposure data developed using the data from the chemical- and scenario-specific exposure monitoring studies -- see Section 2.b.iii for further information.]

[Note: Terbufos labels typically require the use of long-pants, long-sleeved shirts, coveralls, chemical-resistant gloves, protective eyewear, chemical-resistant headgear, and respiratory protection (PF 10 APR with a protection factor of 10 -- organic vapor removing cartridge with a prefilter).]

Given all of the information above, the scenarios that have been developed for each specific occupational use of terbufos include (the scenario numbers correspond to the tables of risk calculations included in the occupational risk calculation aspects of the appendices):

- (1a) loading granular formulations <sup>\*+</sup> (completed using PHED data at varying levels of personal protection);
- (1b) loading 15G formulation in “Lock-N-Load” packaging <sup>x+</sup> (completed using chemical- and scenario-specific data);
- (1c) loading 20CR formulation in bags <sup>x+</sup> (completed using chemical- and scenario-specific data);
- (2a) applying granular formulations using ground-based equipment <sup>\*+</sup> (completed using PHED data at varying levels of personal protection);
- (2b) applying 15G formulation using in-the-row planters and closed tractor cabs <sup>x+</sup> (completed using chemical- and scenario-specific data); and
- (2c) applying 20CR formulation using in-the-row planters and open tractor cabs <sup>x+</sup> (completed using chemical- and scenario-specific data).

- \* considered each appropriate level of personal protection described above for PHED-type assessments
- + assessed at typical (if available) and maximum application rate
- x assessed with the exposure scenarios measured in the monitoring study and the use of respiratory protection in some cases

### **iii. Handler Exposure and Risk Assessment**

The Agency considers how chemical exposures occur (the frequency and duration) and also how chemicals enter the body (because the toxic effects can be different) when developing risk assessments. The Agency completed distinct risk assessments for each duration of concern, using each of the scenarios described above, including:

- Short- and intermediate-term duration for the 15G formulation; and
- Short- and intermediate-term duration for the 20CR formulation

Exposure levels are calculated in a manner that accounts for the method of application, the level of personal protection used during application, and the amount of chemical handled in an application (i.e., proportional to application rate and the amount treated per day). Both daily dermal and daily inhalation exposures have been calculated for each type of assessment completed. In all cases, risks were calculated individually for each route of exposure then added. The toxicological effect of concern determines the way that the dose levels were calculated.

In all cases, daily dermal exposure levels were calculated. Daily dermal exposure is generally calculated using the following formula:

Daily Dermal Exposure (mg ai/day) =

Unit Exposure (mg ai/lb ai) x Application Rate (lb ai/A) x Daily Acres Treated (A/day)

Where:

**Daily Dermal Exposure** = Amount deposited on the surface of the skin that is available for dermal absorption, also referred to as potential dose (mg ai/day);

**Unit Exposure** = Normalized exposure value derived from May 1997 PHED Surrogate Exposure Table or the chemical- and scenario-specific exposure studies (mg ai/pound ai applied);

**Application Rate** = Normalized application rate based on a logical treatment unit such as acres, both typical and maximum values have been used (lb ai/A); and

**Daily Acres Treated** = Normalized application area based on a logical unit treatment such as acres per day (A/day).

Daily dermal dose (i.e., a biologically appropriate and available dose resulting from dermal exposure) was then calculated by normalizing the daily dermal exposure value by body weight. For adult handlers using terbufos, a body weight of 70 kg was used for all exposure scenarios because the toxic effect (cholinesterase inhibition) is not sex-specific. Short-term and intermediate-term dermal risks were calculated using the dermal toxicity studies. As a result, a dermal absorption factor was not applied (but was artificially set to 100 percent in the spreadsheet program used to complete the calculations so no correction to the exposure value in the calculation would occur). Daily potential dermal dose levels were calculated using the following formula:

$$\text{Daily Dermal Dose} \left( \frac{\text{mg ai}}{\text{kg/day}} \right) = \text{Daily Dermal Exposure} \left( \frac{\text{mg ai}}{\text{day}} \right) \times \left( \frac{\text{AbsorptionFactor}(\%/100)}{\text{Body Weight (kg)}} \right)$$

Where:

**Daily Dermal Dose** = the amount of potential dose received from exposure to a pesticide in a given scenario (mg pesticide active ingredient/kg body weight/day);

**Daily Dermal Exposure** = the amount of dermal (on the skin) exposure calculated above (mg pesticide active ingredient/day);

**Absorption Factor** = a measure of the flux or amount of chemical that crosses a biological boundary (% of the total available); and

**Body Weight** = body weight determined to represent the population of interest in a risk assessment (kg).

The process used to calculate the absorbed daily inhalation dose for handlers was similar to that used for the dermal exposure and potential dose. Daily inhalation exposure levels are presented as ( $\mu\text{g/lb ai}$ ) values in the *PHED Surrogate Exposure Table* of May 1997 or as (mg/lb ai) in the chemical- and scenario-specific exposure studies. The calculations essentially mirror those presented above for the dermal route also using a value of 100 percent absorption. [Note: The U.S. EPA Exposure Assessment Guidelines (EPA, 1992) define potential dose as the amount of a chemical at the absorption barrier.]

The handler exposure assessments do not include any dietary or drinking water inputs. They also do not include any dose attributable to nondietary ingestion (e.g., hand-to-mouth activity).

Risks in this assessment were calculated based on the toxicological effect being evaluated. Risks attributable to noncancer effects were calculated in a non-probabilistic manner using the Margin of Exposure (MOE) which is a ratio of the calculated exposure to the toxic endpoint of concern. MOEs attributable to dermal exposure were calculated using the NOAEL from the appropriate dermal toxicity study. Likewise, MOEs attributable to inhalation exposures were calculated using the NOAEL from the subchronic inhalation toxicity study. [Note: See Section 2.b.i for more details about the specific endpoints used in each assessment.] MOEs were calculated using the formula below:

$$MOE = \frac{\text{Endpoint (NOAEL)} \left( \frac{mg}{kg/day} \right)}{\text{Daily Dose} \left( \frac{mg}{kg/day} \right)}$$

Where:

**MOE** = margin of exposure or value used by the Agency to represent noncancer risk or how close a chemical exposure is to being a concern (unitless);

**Daily Dose** = the amount as potential dose (for the dermal calculations) or absorbed dose (for inhalation calculations) received from exposure to a pesticide in a given scenario (mg pesticide active ingredient/kg body weight/day); and

**Endpoint (NOAEL)** = dose level in a toxicity study where no observed adverse effects occur in a study (mg pesticide active ingredient/kg body weight/day).

MOEs were added together in order to consider total risks to handler given that the noncancer toxic effect (cholinesterase inhibition) for each route of exposure (e.g., to the skin and being inhaled) is the same. The equation the Agency uses to add MOEs together is presented below:

$$MOE_{\text{total}} = 1/((1/MOE_a) + (1/MOE_b) + \dots (1/MOE_n))$$

Where:

MOE<sub>a</sub>, MOE<sub>b</sub>, and MOE<sub>n</sub> represent MOEs for each exposure route of concern

A margin of exposure (MOE) uncertainty factor of 100 is considered an appropriate risk level for both the short- and intermediate-term exposures to terbufos for the occupational exposure durations evaluated.

All occupational handler exposure and risk calculations are presented in the tables contained in *Appendix A: Occupational Handler Exposure and Risk Assessment For Terbufos*. Table 1 contains information that can be used to describe the exposure data used in the analysis. The origin of each unit exposure value is presented along with information pertaining to the quality of the data used to calculate each value. The assessment of data quality is based on the number of observations and the available quality control data. The quality control data are assessed based on Agency guidelines and a

grading criteria established by the Pesticide Handlers Exposure Database task force. Other exposure factors (i.e., descriptions of each scenario, application rates, and acres treated), unit exposure values at varying levels of mitigation (such as personal protection), and toxicological parameters used in the noncancer risk assessments are presented in Table 2. Tables 3 and 4 contain the exposure, dose, and MOE calculations completed using the chemical- and scenario-specific data submitted for the 15G product. Tables 5 and 6 contain the exposure, dose, and MOE calculations completed using the chemical- and scenario-specific data submitted for the 20CR product. The calculation of baseline exposures (mg/day) based on unit exposure values derived from PHED, dose levels, and the resulting Margins of Exposure (MOEs) are presented in Table 7. Tables 8, 9, and 10 contain similar calculations for increased levels of personal protection calculated using PHED data. Values calculated for the use of additional mitigation in the form of minimum personal protective equipment are presented in Table 8 (single layer clothing with gloves and a PF 5 respirator) while values calculated for the use of additional mitigation in the form of maximum personal protective equipment (double layer clothing with gloves and a PF 10 respirator) are presented in Table 9. Table 10 contains values that reflect the use of appropriate engineering controls. Tables 11 through 14 in Appendix A present summary results of the risk assessment based on PHED data that are also discussed in more detail in the section 2.c of this document.

The factors described in the exposure calculation above are presented below. These factors include: unit exposures (exposure data); application rate; acres treated per day; and other exposure factors/considerations.

### **Exposure Data**

Two chemical- and scenario-specific exposure studies and a supporting analytical validation study were submitted in support of the reregistration of terbufos. A review by the Agency has determined that these studies are acceptable for regulatory purposes. These studies provide data that are unique in that actual field monitoring of a “Lock-N-Load” type granular loading system was conducted, monitoring of the open loading of a polymer-based granular formulation (the CR) was completed, and the combinations of engineering controls and personal protective equipment are different from the levels typically evaluated by the Agency in the typical tiered approach for adding protective measures in the risk assessment process. The data in these studies has been used for risk assessment purposes. The Agency policy is to combine chemical-specific data and data from PHED in order to obtain a more robust database. The physical differences (e.g., PHED has no closed system granular loading data and the open loading data in PHED are clay-based granules, not low dust polymeric granules) between the data contained in PHED and the data generated in the studies are distinct enough to preclude combining the results of the studies with PHED. However, in addition to using the chemical- and scenario-specific data submitted in support of the reregistration of terbufos, the Agency also calculated exposures, dose levels, and MOEs using PHED data in order to evaluate the risks at lower levels of personal protection than that evaluated in the submitted studies. This exercise allows for a more informed risk management decision. This approach is also consistent with Agency policy in that the chemical-specific data do not address these exposure scenarios without extrapolation so combining the data would be inappropriate.

The submitted studies can be identified by the following information:

- ***Exposure of Farmworkers To Terbufos (CL 92100) While Loading COUNTER 15G Systemic Insecticide-Nematicide With A Lock-N-Load Closed Handling System And Applying COUNTER 15G To Corn At Planting Time;*** (3/26/99) Authored by Joseph Higham; Completed by ABC Laboratories of Columbia MO, Agrisearch of Frederick MD, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 2 of EPA MRID 447933-01, Terbufos 99-02, EXA 99-004, EXA 99-006, and RES 99-003, Sponsored by American Cyanamid.
- ***Exposure of Farmworkers To Terbufos (CL 92100) While Loading COUNTER CR Systemic Insecticide-Nematicide From A Bag And Applying COUNTER CR To Corn At Planting Time;*** (3/26/99) Authored by Joseph Higham; Completed by ABC Laboratories of Columbia MO, HERAC of Greensboro NC, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 3 of EPA MRID 447933-01, Terbufos 99-02, EXA 99-004, EXA 99-006, and RES 99-003, Sponsored by American Cyanamid.
- ***CL92100 (terbufos): Validation of GC/FPD Determinative Methods M3153, M3154, M3155, and M 3156 For The Determination of CL 92100 Residues In, Respectively, Whole Body Dosimeters, Aerosol OT Handwash and Glove Wash Solutions, Air Sampling Tubes and Face/Neck Wipes;*** (3/26/99) Authored by Joseph Higham, Jill Cooper, and Rose Sweeney; Completed by ABC Laboratories of Columbia MO, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 4 of EPA MRID 447933-01, ABC Report 44703, and RES 99-003, Sponsored by American Cyanamid.

***MRID 447933-01/Exhibit 2 (15G Study):*** The field portion of this study was conducted at 15 sites in central Nebraska during the 1998 growing season. All totaled, 30 individual farmworkers were monitored in this study. At each site, two farmworkers (one loaded and the other completed the application) were monitored during the application, with soil incorporation, of terbufos 15G using “Lock-N-Load” type packaging, typical corn planters, and closed cab tractors (open cabs were used for 2 replicates). All planters were either 6 or 8 row devices. Corn was treated at an average application rate of 1.23 lb ai/acre (the label maximum is 1.3 lb ai/acre) at planting. The total amount of active ingredient loaded in this study ranged from 66 to 96 pounds while the total amount of active ingredient applied in this study ranged from 35.8 to 81.9 pounds. The exposure time periods for loaders ranged from 0.37 to 0.78 hours while the time periods for the applicators ranged from 3.8 to 8.7 hours. Exposure monitoring for dermal and inhalation exposure was completed using whole-body dosimetry, aqueous handwashes, aqueous glove washes, facial/neck wipe, inhalation monitoring in the breathing zone using personal sampling pumps, and inhalation monitoring in the breathing zone

using personal sampling pumps pulling air through a respirator cartridge attached to the sampling device. All data except for the glove washes and the respirator cartridge protected inhalation monitoring data were used in the risk assessment. These data were not used in the assessment because the monitoring techniques are not considered to be acceptable approaches by the Agency.

The loaders in this study used the “Lock-N-Load” type packaging as described above. Additionally, they wore normal work clothing, nitrile gloves, and a chemical-resistant apron (i.e., treated as a double layer of protection by the Agency for the purposes of this assessment). The applicators in this study used closed cabs as described above. Additionally, they wore normal work clothing, nitrile gloves, coveralls, protective eyewear, and an air purifying respirator with an organic vapor removing cartridge. [Note: Terbufos labels typically require the use of long-pants, long-sleeved shirts, coveralls, chemical-resistant gloves, protective eyewear, chemical-resistant headgear, and respiratory protection (PF 10 APR -- organic vapor removing cartridge with a prefilter).]

The analytical results of this study indicate that terbufos was present in the 15G formulation used to make all applications in the study (avg = 105 % of the nominal 15 w/w concentration) and that terbufos was stable over time in the solutions used to dose the field fortification samples (avg = 99.6 % of nominal). The detection and quantification limits established in the study and verified by the Agency are as follows:

Exposure Media	Detection Limit	Quantification Limit
Air Tubes	4.0 (ng/sample)	20.0 (ng/sample)
Whole-Body Dosimeters	0.20 ( $\mu\text{g}/\text{sample}$ )	1.0 ( $\mu\text{g}/\text{sample}$ )
Handwashes	0.10 ( $\mu\text{g}/\text{sample}$ )	0.50 ( $\mu\text{g}/\text{sample}$ )
Face/neck wipes	0.10 ( $\mu\text{g}/\text{sample}$ )	0.50 ( $\mu\text{g}/\text{sample}$ )

Laboratory recovery data are generated to ensure the daily performance of an analytical method during the analysis of field samples. The laboratory recovery data for each media from this study are summarized in the table below:

Exposure Media	Fortification Range ( $\mu\text{g}/\text{sample}$ )	N	Results avg $\pm$ sd (%) & CV
Air Tubes	0.020 - 2000	12	88 $\pm$ 16 CV = 18.2
Whole-Body Dosimeters	1.0 - 25.0	18	92 $\pm$ 18 CV = 19.6
Handwashes	0.5 - 2.5	17	88 $\pm$ 11 CV = 12.5

Exposure Media	Fortification Range ( $\mu\text{g}/\text{sample}$ )	N	Results avg $\pm$ sd (%) & CV
Face/neck wipes	0.5 - 5.0	10	94 $\pm$ 9.4 CV = 10.0

Field and storage stability recovery data are generated to ensure the stability of residues during field sampling and over storage until analysis. In this study, the field recovery samples also provided data for storage stability as the samples were generated, stored, and analyzed concurrently with the field samples. The field recovery data for each media from this study are summarized in the table below:

Exposure Media	Fortification Range ( $\mu\text{g}/\text{sample}$ )	N	Results avg $\pm$ sd (%) & CV
Air Tubes	0.05 - 1.00	18	62 $\pm$ 16 CV = 25.8
Whole-Body Dosimeters	5.0 - 10.0	18	86 $\pm$ 8.0 CV = 9.3
Handwashes	2.5 - 5.0	18	79 $\pm$ 8.4 CV = 10.6
Face/neck wipes	2.5 - 5.0	18	62 $\pm$ 5.5 CV = 8.9

Based on the PHED grading criteria, the analytical results of this study would be graded as a “B” for all media except for face/neck wipes which would be an “A” grade dataset. These grades are provided to allow direct comparisons of data quality with the PHED data used in the assessment.

Unit exposures were calculated by the registrants and verified by the Agency. These values were used for risk assessment purposes by the Agency. The values were calculated by correcting for the average field recovery values summarized above. The unit exposure values used by the Agency in the risk assessment were only based on the use of protective gloves (i.e., glove wash data were not used in the risk assessment) and the use of no respiratory protection (i.e., inhalation monitoring data generated by pulling air through a respirator cartridge was not used in the risk assessment). The unit exposure values used in the assessment reflect only the use of closed cabs during application.

The results of this study indicate very low exposure levels as would be expected given the exposure scenarios that were monitored (i.e., lower exposure activities with high levels of personal protection). There was a high percentage of values that were less than either the limit of detection (LOD) or limit of quantification (LOQ). In such cases, the values used to calculate the unit exposure values were either  $\frac{1}{2}$  of the LOD or LOQ as appropriate. The nondetect values presented in the table below fit both categories. It should be noted, however, that a majority of the whole-body dosimeters contained detectable residues of terbufos. These study results are summarized in the following table:

Job Function	Data Type	Dermal Data		Inhalation Data	
		Unit Exposure (mg/lb ai)	Nondetects (%)	Unit Exposure (mg/lb ai)	Nondetects (%)
Loaders	Minimum	1.21x10 <sup>-5</sup>	WBD: 6.7 HW: 93.3 FNW: 100	5.28 x10 <sup>-7</sup>	46.7
	Geo. Mean	5.20 x10 <sup>-5</sup>		7.84 x10 <sup>-6</sup>	
	Maximum	3.61x10 <sup>-4</sup>		6.50 x10 <sup>-5</sup>	
Applicators	Minimum	7.32 x10 <sup>-6</sup>	WBD: 33.3 HW: 93.3 FNW: 100	4.25 x10 <sup>-7</sup>	100
	Geo. Mean	3.51 x10 <sup>-5</sup>		2.43 x10 <sup>-6</sup>	
	Maximum	1.65 x10 <sup>-4</sup>		2.04 x10 <sup>-5</sup>	

WBD = whole-body dosimeter, HW = handwash, FNW: face and neck wipe

**MRID 447933-01/Exhibit 3 (20CR Study):** The field portion of this study was conducted at 15 sites in central Ohio and Indiana during the 1998 growing season. All totaled, 30 individual farmworkers were monitored in this study. At each site, two farmworkers (one loaded and the other completed the application) were monitored during the application, with soil incorporation, of terbufos 20CR using bags, typical corn planters, and open cab tractors. All planters were either 4, 6, or 8 row devices. The 20CR formulation of terbufos is a low dust (as indicated in the dust generation/attrition study completed by American Cyanamid) polymeric granule that differs from typical clay-based granules because of its stability and the release characteristics. Corn was treated at an average application rate of 1.31 lb ai/acre (the label maximum is 1.3 lb ai/acre) at planting. The total amount of active ingredient loaded in this study ranged from 40 to 80 pounds while the total amount of active ingredient applied in this study ranged from 27.8 to 62.6 pounds. The exposure time periods for loaders ranged from 0.1 to 1.3 hours while the time periods for the applicators ranged from 3.0 to 9.5 hours. Exposure monitoring for dermal and inhalation exposure was completed using whole-body dosimetry, aqueous handwashes, aqueous glove washes, facial/neck wipe, inhalation monitoring in the breathing zone using personal sampling pumps, and inhalation monitoring in the breathing zone using personal sampling pumps pulling air through a respirator cartridge attached to the sampling device. All data except for the glove washes and the respirator cartridge protected inhalation monitoring data were used in the risk assessment. These data were not used in the assessment because the monitoring techniques are not considered to be acceptable approaches by the Agency.

The loaders wore normal work clothing, protective eyewear, nitrile gloves, chemical-resistant apron (i.e., treated as a double layer of protection by the Agency for the purposes of this assessment), and respiratory protection (PF 10 APR -- organic vapor removing cartridge with a prefilter). The applicators in this study used open cabs as described above. Additionally, they wore normal work clothing, nitrile gloves, coveralls, protective eyewear, and an air purifying respirator with and organic vapor removing cartridge. [Note: Terbufos labels typically require the use of long-pants, long-sleeved shirts, coveralls, chemical-resistant gloves, protective eyewear, chemical-resistant headgear, and respiratory protection (PF 10 APR -- organic vapor removing cartridge with a prefilter).]

The analytical results of this study indicate that terbufos was present in the 20CR formulation

used to make all applications in the study (avg = 103 % of the nominal 20 w/w concentration) and that terbufos was stable over time in the solutions used to dose the field fortification samples (avg = 100.5 % of nominal). The detection and quantification limits established in the study and verified by the Agency are as follows (the same as for the 15G study described above):

Exposure Media	Detection Limit	Quantification Limit
Air Tubes	4.0 (ng/sample)	20.0 (ng/sample)
Whole-Body Dosimeters	0.20 ( $\mu\text{g}/\text{sample}$ )	1.0 ( $\mu\text{g}/\text{sample}$ )
Handwashes	0.10 ( $\mu\text{g}/\text{sample}$ )	0.50 ( $\mu\text{g}/\text{sample}$ )
Face/neck wipes	0.10 ( $\mu\text{g}/\text{sample}$ )	0.50 ( $\mu\text{g}/\text{sample}$ )

Laboratory recovery data are generated to ensure the daily performance of an analytical method during the analysis of field samples. The laboratory recovery data for each media from this study are summarized in the table below:

Exposure Media	Fortification Range ( $\mu\text{g}/\text{sample}$ )	N	Results avg $\pm$ sd (%) & CV
Air Tubes	0.020 - 8.01	19	83 $\pm$ 9.9 CV = 11.9
Whole-Body Dosimeters	1.0 - 25.0	18	93 $\pm$ 6.9 CV = 7.4
Handwashes	0.5 - 5.0	17	92 $\pm$ 6.6 CV = 7.2
Face/neck wipes	0.5 - 5.0	11	95 $\pm$ 11 CV = 11.6

Field and storage stability recovery data are generated to ensure the stability of residues during field sampling and over storage until analysis. In this study, the field recovery samples also provided data for storage stability as the samples were generated, stored, and analyzed concurrently with the field samples. The field recovery data for each media are summarized below:

Exposure Media	Fortification Range ( $\mu\text{g}/\text{sample}$ )	N	Results avg $\pm$ sd (%) & CV
Air Tubes	0.05 - 1.00	24	66 $\pm$ 7.1 CV = 10.8

Exposure Media	Fortification Range ( $\mu\text{g}/\text{sample}$ )	N	Results avg $\pm$ sd (%) & CV
Whole-Body Dosimeters	5.0 - 10.0	24	81 $\pm$ 12 CV = 14.8
Handwashes	2.5 - 5.0	24	76 $\pm$ 7.3 CV = 9.6
Face/neck wipes	2.5 - 5.0	24	60 $\pm$ 5.6 CV = 9.3

Based on the PHED grading criteria, the analytical results of this study would be graded as a “B” for the face/neck wipes and inhalation monitors. The whole-body dosimeters and handwash samples would be an “A” grade dataset. These grades are provided to allow direct comparisons of data quality with the PHED data used in the assessment.

Unit exposures were calculated by the registrants and verified by the Agency. These values were used for risk assessment purposes by the Agency. The values were calculated by correcting for the average field recovery values summarized above. The unit exposure values used by the Agency in the risk assessment were only based on the use of protective gloves (i.e., glove wash data were not used in the risk assessment) and the use of no respiratory protection (i.e., inhalation monitoring data generated by pulling air through a respirator cartridge was not used in the risk assessment). The unit exposure values used in the assessment reflect only the use of closed cabs during application.

The results of this study indicate very low exposure levels as would be expected given the exposure scenarios that were monitored (i.e., lower exposure activities with high levels of personal protection). There was a high percentage of values that were less than either the limit of detection (LOD) or limit of quantification (LOQ). In such cases, the values used to calculate the unit exposure values were either  $\frac{1}{2}$  of the LOD or LOQ as appropriate. The nondetect values presented in the table below fit both categories. It should be noted, however, that a majority of the whole-body dosimeters contained detectable residues of terbufos. These study results are summarized in the following table:

Job Function	Data Type	Dermal Data		Inhalation Data	
		Unit Exposure (mg/lb ai)	Nondetects (%)	Unit Exposure (mg/lb ai)	Nondetects (%)
Loaders	Minimum	1.00 $\times 10^{-5}$	WBD: 20.0 HW: 100 FNW: 100	4.16 $\times 10^{-6}$	6.7
	Geo. Mean	3.69 $\times 10^{-5}$		6.81 $\times 10^{-5}$	
	Maximum	1.60 $\times 10^{-4}$		3.24 $\times 10^{-4}$	

Job Function	Data Type	Dermal Data		Inhalation Data	
		Unit Exposure (mg/lb ai)	Nondetects (%)	Unit Exposure (mg/lb ai)	Nondetects (%)
Applicators	Minimum	9.58 x10 <sup>-6</sup>	WBD: 93.3 HW: 100 FNW: 100	5.92 x10 <sup>-7</sup>	100
	Geo. Mean	1.59 x10 <sup>-5</sup>		1.26 x10 <sup>-6</sup>	
	Maximum	3.88 x10 <sup>-5</sup>		5.39 x10 <sup>-6</sup>	

WBD = whole-body dosimeter, HW = handwash, FNW: face and neck wipe

**MRID 447933-01/Exhibit 4 (Lab Validation Study):** A laboratory validation study was completed to establish the parameters for the analytical methods used for both the 15G and 20CR studies described above. The results indicate acceptable recoveries for all media that are similar to the concurrent laboratory recovery data generated in the two exposure studies.

**Pesticide Handlers Exposure Database (PHED) Version 1.1:** For the remaining aspects of the risk assessment, the *Pesticide Handlers Exposure Database (PHED) Version 1.1* was used to assess handler exposures for regulatory actions when chemical-specific monitoring data are not available.

PHED was designed by a task force of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide regulation, and member companies of the American Crop Protection Association. PHED is a software system consisting of two parts -- a database of measured exposure values for workers involved in the handling of pesticides under actual field conditions and a set of computer algorithms used to subset and statistically summarize the selected data. Currently, the database contains values for over 1,700 monitored application events (i.e., referred to as replicates).

Users select criteria to subset the PHED database to reflect the exposure scenario being evaluated. The subsetting algorithms in PHED are based on the central assumption that the magnitude of handler exposures to pesticides are primarily a function of activity (e.g., mixing/loading, applying), formulation type (e.g., wettable powders, granulars), application method (e.g., aerial, groundboom), and clothing scenarios (e.g., gloves, double layer clothing).

Once the data for a given exposure scenario have been selected, the data are normalized (i.e., divided by) by the amount of pesticide handled resulting in standard unit exposures (milligrams of exposure per pound of active ingredient handled). Following normalization, the data are statistically summarized. The distribution of exposure values for each body part (e.g., chest upper arm) is categorized as normal, lognormal, or "other" (i.e., neither normal nor lognormal). A central tendency value is then selected from the distribution of the exposure values for each body part. These values are the arithmetic mean for normal distributions, the geometric mean for lognormal distributions, and the median for all "other" distributions. Once selected, the central tendency values for each body part

are composited into a “best fit” exposure value representing the entire body. The unit exposure values calculated by PHED generally range from the geometric mean to the median of the selected data set. It should also be noted that distributional analyses of the data contained in PHED are not done for the risk assessment process because the available data do not lend themselves to this kind of analysis.

To add consistency to the values produced from this system and to ensure quality control, the PHED Task Force has evaluated all data within the system and has developed a set of grading criteria to characterize the quality of the original study data. The assessment of data quality is based on the number of observations and the available quality control data. These evaluation criteria and the caveats specific to each exposure scenario are summarized in Appendix A/Table 1. While data from PHED provide the best available information on handler exposures, it should be noted that some aspects of the included studies (e.g., duration, acres treated, pounds of active ingredient handled) may not accurately represent labeled uses in all cases. The Agency has developed a series of tables of standard unit exposure values (i.e., representing the “best fit” for each dataset) for many occupational scenarios that can be utilized to ensure consistency in exposure assessments. The unit exposures used in this risk assessment derived from PHED are excerpted from the latest version of this table.

### **Application Rate**

In addition to PHED, the application rate and daily amount treated (usually acres per day) are also key elements in the calculation of handler exposures. A range of application rates, derived from terbufos labeling and the data from the QUA, serves as the basis for this assessment. Maximum application rates range from 1.3 pounds of active ingredient per acre on corn up to 1.96 pounds of active ingredient per acre on sorghum and sugar beets. A SLN label for North Carolina also exists which allows corn applications up to 2.6 lb ai/acre. The recent QUA was used to establish average application rates for various agricultural crops (i.e., average application rates used to represent typical application rates as noted earlier). The range of average application rates calculated in this analysis ranged from about 0.7 for sorghum up to about 1.1 lb ai/acre for corn. Wherever available, both maximum and average application rates are used in each assessment.

### **Amount Treated**

The amount treated per day, usually expressed as the number of acres treated per day, is another critical factor in the exposure calculations for handlers. The Agency typically uses acres treated per day values that are thought to represent 8 solid hours of application work for specific types of application equipment. The Agency has used the same default values for acres treated per day for several years. These values were based on data included in PHED, consideration of agricultural engineering principles, and use and usage information. Through NAFTA (North American Free Trade Agreement) auspices, there is currently an initiative underway to harmonize the acres treated per day values used for the purposes of risk assessment. The values currently used by the Agency are similar or equivalent to those being discussed in the NAFTA working group. The actual values, specific to each scenario in the risk assessment, are presented below:

- **For Corn:** Agency corn cluster typical (69 acres/day) and maximum (213 acres/day) values were used along with a “likely maximum” value of 180 acre/day provided to the Agency by American Cyanamid;
- **For Sorghum:** Agency corn cluster typical (69 acres/day) and maximum (213 acres/day) values were used along with a “likely maximum” value of 130 acres/day provided to the Agency by American Cyanamid; and
- **For Sugar Beets:** Agency corn cluster typical (69 acres/day) and maximum (213 acres/day) values were used along with a “likely maximum” value of 130 acres/day provided to the Agency by American Cyanamid.

[Note: The corn cluster acreage values were used because the applications and practices are anticipated to be similar with respect to the application process. The acreage values supplied by American Cyanamid were also used for flexibility in the risk management process. It should also be considered that corn production accounts for a majority of terbufos use (i.e., ~90 percent).]

### **Other Factors/Considerations**

In addition to the information presented above, the following assumptions and factors were used in order to complete this exposure assessment:

- As indicated above, the Agency has developed a series of unit exposures that can be used in risk assessments for different application equipment and varying levels of protection. Due to a lack of empirical, scenario-specific data, unit exposures are sometimes calculated using generic protection factors that are intended to represent the protectiveness of various risk mitigation options (i.e., the use of PPE or Personal Protective Equipment and engineering controls). PPE protection factors include those representing layers of clothing (50%), chemical-resistant gloves (90%), and respiratory protection (80 to 90% depending upon mitigation selected). Engineering controls are generally assigned a protection factor of 98 percent. Engineering controls may include closed mixing/loading systems for liquids, closed cabs/cockpits, and closed gravity fed loading systems for granulars. Adjustments to exposure values using protection factors are made using the following equation and are completed only in lieu of scenario-specific monitoring data (PF = Protection Factor expressed as a percent reduction):

$$\text{PF Adjusted Exposure} = (1 - (\text{PF}/100)) * (\text{Nonadjusted Exposure Value})$$

Baseline occupational assessment unit exposures are typically calculated based on empirical data that is reflective of the scenario. In other words, the empirical data in PHED used to generate exposure values are monitoring data that were generated in which the individuals tested were wearing clothing similar to the occupational baseline (long pants and long-sleeved shirt) and the homeowner applicator (short pants and short-sleeved shirts).

- Average body weight of an adult handler is 70 kg because the NOAELs used for the short- and intermediate-term assessments is appropriate to all adult populations based on the toxicological

effect.

- Calculations are completed for a range of typical and maximum application rates for various crops in order to bracket handler risk levels associated with specific application equipment. Where available, typical application rates from the recent *Quantitative Usage Analysis* (QUA) were also used in the calculations.
- Risk mitigation options for occupational handlers are based on the Worker Protection Standard and the criteria established by the Agency in the guidance for the Pesticide Handlers Exposure Database (i.e., extra layers of clothing, chemical-resistant gloves, respirators, closed-systems, etc.).
- The Agency believes that intermediate-term exposures are very plausible based upon the cultural practices associated with the crops that can be treated with terbufos. In fact, data supplied by American Cyanamid indicates a 4 to 6 week application interval which is well within the range of intermediate-term exposures.

#### **iv. Post-Application Exposure Scenarios**

The Agency does not believe that there is a significant potential for post-application exposures from terbufos based on the manner in which it is applied and soil incorporated, the timing of application, the frequency of application, and the lack of known activities that would occur in the treated areas that might contribute to exposure. Also, the Agency does not believe that there is any significant potential for drift into adjoining areas such as residential neighborhoods. Given this perspective, the Agency believes that the Restricted Entry Intervals established by the U.S. EPA Worker Protection Standard are adequate to protect any workers who may enter a treated area.

#### **c. Occupational and Residential Risk Assessment Summary and Characterization**

The risk assessment completed in Section 2.b is summarized herein. Please refer to the tables presented in Appendix A as they are the basis for this risk assessment. This section of the document presents the results of the risk assessment and the factors that should be considered when interpreting the results.

##### ***i. General Risk Characterization Considerations***

A risk assessment was also completed using the data developed in the studies presented above. The Agency has not formally reviewed the risk assessment. However, the Agency has considered the factors used in the risk assessment submitted by American Cyanamid so that consistency between the current Agency assessment and the submitted document can be evaluated. The submitted risk assessment can be identified by the following:

- ***Occupational Exposure and Risk Assessment For Loaders and Applicators Handling Terbufos Products and Supporting Worker Exposure Studies***; (3/26/99) Authored by Joseph Higham, Richard Honeycutt, D. Larry Merricks, Rose A. Sweeney, Cassi L. Walls, and Susan H Youngren; Completed by ABC Laboratories of Columbia MO, HERAC of Greensboro NC, Agrisearch of Frederick MD, Novigen Sciences of Washington DC, and American Cyanamid of Princeton NJ.; Project ID #s include: Exhibit 1 of EPA MRID 447933-01, Terbufos 99-02, EXA 99-004, EXA 99-006, and RES 99-003, Sponsored by American Cyanamid.

The major differences between the assessment completed by American Cyanamid and the risk assessment completed by the Agency include:

- The Agency used an endpoint for the 15G of 0.32 mg/kg/day where American Cyanamid used an endpoint of 0.75 mg/kg/day (all other endpoints used were consistent);
- The Agency did not use the glove wash or respirator cartridge in-line inhalation monitoring data in order to develop more scenarios in the risk assessment based on differing levels of personal protection. American Cyanamid used these data to develop additional scenarios which is considered inappropriate by the Agency given the monitoring techniques involved (i.e., open loading of the 15G); and
- The Agency used exposure data across the distribution from the study (i.e., minimum, maximum, and geometric means) where American Cyanamid apparently used only the geometric mean values.

Several issues must be considered that pertain to the quality of the assessment and when interpreting the results of the occupational handler and residential postapplication risk assessment. These include:

- The vapor pressure of terbufos is  $3.16 \times 10^{-4}$  torr (i.e., consider with inhalation monitor field recovery results).
- High quality chemical- and scenario-specific exposure data were used to develop this risk assessment for terbufos. These data were used to calculate risks that are reflective of the scenarios that were monitored. To add flexibility to the risk assessment process, the Agency also calculated exposures, with less personal protective measures than monitored in the study to assess risks at various levels of protection. This analysis was completed essentially for informational purposes as the data generated in the two chemical-specific studies is of high quality and directly applicable to the exposure scenarios.

- The chemical- and scenario-specific exposure data has many values that are at or below either the limit of detection or limit of quantification. The Agency followed standard practices in that ½ of the appropriate value (LOD or LOQ) was used for risk assessment purposes when no quantifiable residues were observed. The number and pattern of samples where measured values were at or below the LOQ or LOD were consistent with Agency expectations given the scenarios that were considered in these two studies were expected to be low exposure job functions.
- Several generic protection factors were used to calculate handler exposures. The protection factors used for clothing layers and gloves have not been completely evaluated by the Agency. There is an ongoing project through NAFTA to address the issue of protection factors (a draft document assessing protection factors using PHED has been completed). The key element being evaluated by the Agency are the factors for clothing and gloves. The value used for respiratory protection is based on the *NIOSH Respirator Decision Logic*. It should also be noted that the value used for gloves is in the range that OSHA and NIOSH often use.
- Exposure factors used to calculate daily exposures to handlers are based on applicable data if available. In this case, the corn cluster analysis completed in 1993 by the Agency served as the basis for the acreage estimates used in the risk assessment along with use and usage data provided by the registrant.
- The Agency normally completes both short- and intermediate-term occupational risk assessments for noncancer endpoints.
- Job functions are combined for some scenarios where field logistics might dictate that a single person would complete all aspects of the application process (e.g., mixer/loaders and groundboom or airblast applications). In these cases, the Agency has calculated values for each aspect of the job then combined them.
- The Agency always considers the maximum application rates allowed by labels in its risk assessments in order to be able to consider what is legally possible based on the label in order to ensure proper stewardship. If more information is available concerning the use patterns of the chemical, the Agency tries to incorporate it into the risk assessment process. Typical application rates were available from a recent analysis. The results of this analysis indicate that in most cases, typical application rates differ from maximum application rates. The Agency used these rates in the assessment. However, the impact on the calculated risks is small because there is little difference between the typical and maximum application rates.
- The geometric mean unit exposure values calculated from the chemical- and scenario-specific exposure studies or the unit exposure values from PHED that are also a measure of central tendency of the data were combined with typical and maximum measures of the amount of chemical that can be handled in a day (i.e., based on application rate and acres treated). These combinations of input variables are thought to represent typical to maximum exposures. If the maximum measured exposure value is used, the calculated exposures are thought to represent a bounding estimate of exposure, especially when coupled with maximum measures of the

amount handled.

Refinement of the ORE exposure and risk assessment calculations presented in this chapter is possible if the issues presented above are addressed by the registrant or if more refined approaches and data become available to HED.

## ii. Occupational Handler Risk Summary

In this current assessment, which is based on a different approach from the previous assessments completed for terbufos, risks for handlers were assessed using separate toxicological endpoints for both dermal and inhalation exposures. The resulting risks (MOE values) were then added in order to obtain an overall risk for each applicator that accounted for both dermal and inhalation exposures for each exposure duration considered. All of the risk calculations for occupational handlers completed in this assessment are included in Appendix A. The specifics of each of table included in Appendix A are described below as well as a summary of the risks for each exposure scenario.

- **Table 1: Sources of Exposure Data Used in the Occupational Terbufos Handler Exposure and Risk Calculations** Describes the sources of the exposure data used in all of the occupational handler calculations.
- **Table 2: Input Parameters For Terbufos Occupational Handler Exposure and Risk Calculations** Presents the exposure values and other exposure factors used in the occupational handler assessment.
- **Table 3: Terbufos Occupational Handler Exposure Calculations Using Data From MRID 447933-01 For 15G Formulation** Exposure and dose calculations are included in this table that were developed based on the recently completed chemical- and scenario-specific study with the 15G formulation using “Lock-N-Load” with closed cab tractors. Inhalation values are considered with and without a respirator (i.e., not using monitoring data, a protection factor of 10 was applied to account for the use of a cartridge, negative pressure APR).
- **Table 4: Terbufos Occupational Handler Risk Calculations Using Data From MRID 447933-01 For 15G Formulation** MOE calculations are included in this table that were developed based on the recently completed chemical- and scenario-specific study with the 15G formulation using “Lock-N-Load” with closed cab tractors. MOEs are presented for applicators, loaders, and combined loader/applicators. Inhalation values are considered with and without a respirator (i.e., not using monitoring data, a protection factor of 10 was applied to account for the use of a cartridge, negative pressure APR).
- **Table 5: Terbuphos Occupational Handler Exposure Calculations Using Data From MRID 447933-01 For 20 CR Formulation** Exposure and dose calculations are included in this table that were developed based on the recently completed chemical- and scenario-specific study with the 20CR formulation using open bags and open cab tractors. Inhalation values are considered with and without a respirator (i.e., not using monitoring data, a protection

factor of 10 was applied to account for the use of a cartridge, negative pressure APR).

- **Table 6: Terbufos Occupational Handler Risk Calculations Using Data From MRID 447933-01 For 20 CR Formulation** MOE calculations are included in this table that were developed based on the recently completed chemical- and scenario-specific study with the 15G formulation using open bags and open cab tractors. MOEs are presented for applicators, loaders, and combined loader/applicators. Inhalation values are considered with and without a respirator (i.e., not using monitoring data, a protection factor of 10 was applied to account for the use of a cartridge, negative pressure APR).
- **Table 7: Terbufos Occupational Handler Exposure and Risk Calculations At The Baseline Protection Level Using PHED Data** Represents typical work clothing or a long-sleeved shirt and long pants with no respiratory protection. No chemical-resistant gloves are included in this scenario. Therefore, some scenarios have no baseline dermal exposure assessments (see notes on Table 2). [Note: The calculations from this table have been used to develop the summary in Tables 11, 12, 13 and 14.]
- **Table 8: Terbufos Occupational Handler Exposure and Risk Calculations At The Minimum PPE Protection Levels Using PHED Data** Represents the baseline scenario with the use of chemical-resistant gloves and PF 5 respirators. [Note: The calculations from this table have been used to develop the summary in Tables 11, 12, 13 and 14.]
- **Table 9: Terbufos Occupational Handler Exposure and Risk Calculations At The Maximum PPE Protection Levels Using PHED Data** Represents the baseline scenario with the use of an additional layer of clothing (e.g., a pair of coveralls), chemical-resistant gloves, and, in some cases, a PF 10 respirator. [Note: The calculations from this table have been used to develop the summary in Tables 11, 12, 13 and 14..]
- **Table 10: Terbufos Occupational Handler Exposure and Risk Calculations At The Engineering Control Protection Levels Using PHED Data** Represents the use of an appropriate engineering control such as a closed tractor cab or closed loading system for granulars or liquids. Engineering controls are not applicable to handheld application methods there are no known devices that can be used to routinely lower the exposures for these methods. [Note: The calculations from this table have been used to develop the summary in Tables 11, 12, 13 and 14.]
- **Table 11: Terbufos MOEs Attributable to Occupational Dermal Exposure Using PHED Data** Summarizes all MOEs calculated for dermal exposures at each level of personal protection (i.e., baseline through engineering controls). [Note: See tables 7 through 10 for calculations of specific MOE values.]

- **Table 12: Terbufos MOEs Attributable to Occupational Inhalation Exposure Using PHED Data** Summarizes all MOEs calculated for inhalation exposures at each level of personal protection (i.e., baseline through engineering controls). [Note: See tables 7 through 10 for calculations of specific MOE values.]
- **Table 13: Terbufos MOEs Attributable to Combined Dermal and Inhalation Exposures To The 15G Formulation Using PHED Data** Presents combined dermal and inhalation MOEs with each possible combination of dermal and respiratory protection considered in this assessment. [Note: See tables 7 through 10 for calculations of specific MOE values.]
- **Table 14: Terbufos MOEs Attributable to Combined Dermal and Inhalation Exposures To The 20CR Formulation Using PHED Data** Presents combined dermal and inhalation MOEs with each possible combination of dermal and respiratory protection considered in this assessment. [Note: See tables 7 through 10 for calculations of specific MOE values.]

Tables 1 through 6 of Appendix A illustrate how the calculations were performed to define the noncancer risks (i.e., MOEs) for terbufos handlers using the chemical- and scenario-specific data that were recently completed by the registrant, American Cyanamid. These exposure data represent the best source of data currently available to the Agency for completing an assessment for terbufos as the data are of high quality and are intended to be specific for the scenarios being considered in this assessment. The chemical- and scenario-specific data (for the 15G and 20 CR formulations) have not been integrated with PHED data for a concurrent analysis because the Agency believes that there are physical differences in the formulations and packaging as well as the levels of personal protection evaluated in the study that preclude combining the data. These data are also unique because they represent a slightly higher level of personal protection than is typically considered in the risk assessment process.

Tables 7 through 10 present the calculations of exposure, dose, and risk for different levels of personal protection using data from PHED that are most like the exposure scenarios anticipated for terbufos. [Note: The PHED data used are not all considered high quality data as are the chemical- and scenario-specific data.] The additional calculations were completed using PHED data in order to provide flexibility in the risk management process in case American Cyanamid decides to market terbufos in packaging other than “Lock-N-Load” or if other labels for terbufos need to be considered by the Agency in the future from another registrant. All of the scenarios considered using PHED were completed using levels of personal protection that did not incorporate as many measures as were included in the recent studies. This is important because a basic tenant of industrial hygiene is not to add unnecessary levels of personal protection because it can be cumbersome, expensive, and create additional risks (e.g., pulmonary function related to respirator use). The major differences between the recent chemical- and scenario-specific data and the available PHED data are the formulations used (i.e., open bag, clay-based granules in PHED versus open-bag, low dust polymeric granules or clay-based granules in “Lock-N-Load” packaging in the studies). The other major differences are the levels of personal protection in each study compared to the data in PHED. A series of generic protection factors were used to complete the normal tiered assessment using PHED data as opposed to completing the assessment using direct monitoring data from the recent exposure studies. Tables 11 and 12 provide a summary of the dermal MOEs and inhalation MOEs, respectively, of the values

calculated using PHED data. Tables 13 and 14 provide a summary of the MOEs calculated using PHED with a variety of combinations of personal protection.

This risk assessment should be interpreted in the context of the risk characterization issues presented above and also that the Agency uses the best available data to complete risk assessments. The most recent chemical- and scenario-specific exposure data were used as described above. The Agency also used available use and usage information to establish the amount of terbufos that can be handled on a daily basis. Maximum application rates were derived directly from terbufos labels. The recent use and usage report was also used to define average application rates as well as the annual frequency of application rates per crop. Exposure factors (e.g., body weight, amount treated per day, protection factors, etc.) are all standard values that have been used by the Agency over several years and are derived from peer reviewed sources whenever possible (e.g., Exposure Factors Handbook or NIOSH sources).

The risks are summarized based on the specific crops on which terbufos is used and the lowest level of personal protection where the Agency has no concern. The level of concern for all non-cancer assessments is established by an uncertainty factor of 100 for short- and intermediate-term exposures.

#### **For the 15G:**

**For The 15G Formulation on Corn:** The maximum application rate on the Federal Section 3 label is 1.3 lb ai/acre while the 24C/SLN label from North Carolina allows applications up to 2.6 lb ai/acre. Additionally, a typical application rate of 1.1 lb ai/acre was considered. The 15G is currently marketed by American Cyanamid only in “Lock-N-Load” packaging. The chemical- and scenario-specific study reflects this pattern. When the geometric mean values (i.e., a measure of central tendency like the values calculated with PHED) from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs for all scenarios (loaders, applicators, and combined loader/applicators) considered were >100 if a PF 10 respirator is required even if the loading and application job functions were combined (i.e., also includes SLN/24C label).

When the maximum measured values from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs were >100 for loaders at all but the maximum use scenario (i.e., 213 acres at 1.3 lb ai/acre where MOE=85) and were >100 for all applicator scenarios considered (i.e., SLN/24C label MOE >100 for applicator only and low acreage loading). MOEs were >100 for combined loader/applicators using the maximum exposure value only for the minimum acreage and typical application rate scenario (i.e., SLN/24C label MOEs also <100 for combined job functions).

Using PHED data as the basis for the assessment (keeping in mind that this assessment is based on less personal protective equipment than the study), MOEs for loader and applicators never exceeded 100 for any scenario even with the use of engineering controls.

Dermal and inhalation risks were also considered separately in the interpretation of this risk assessment. MOEs attributable to dermal exposure >100 when the maximum exposure value was considered from the chemical- and scenario-specific exposure study indicating that the MOEs attributable to inhalation exposure are the risk drivers in this assessment. The MOEs attributable to inhalation exposure are generally similar to those for combined exposures summarized above. The same pattern emerges when PHED data are considered, MOEs attributable to dermal exposure >100 when engineering controls are used. However, inhalation MOEs never exceed 100 even if PF10 APR respirators or engineering controls are used.

To summarize, the use of terbufos 15G on corn is not a concern for the Agency if the loading and application events (or even when combined) are made using closed “Lock-N-Load” systems and closed cabs as monitored in the chemical- and scenario-specific exposure studies. Other exposure scenarios, using lesser levels of personal protection were also considered in this assessment based on data from PHED. The Agency has a concern for all of these scenarios.

**For The 15G Formulation on Sorghum:** The maximum application rate on the Federal Section 3 label is 1.96 lb ai/acre. Additionally, a typical application rate of 1.3 lb ai/acre was considered. The 15G is currently marketed by American Cyanamid only in “Lock-N-Load” packaging. The chemical- and scenario-specific study reflects this pattern. When the geometric mean values (i.e., a measure of central tendency like the values calculated with PHED) from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs for all scenarios (loaders, applicators, and combined loader/applicators) considered were >100 even if the loading and application job functions were combined. Respirators (PF =10) are, however, required for the maximum application rate scenarios (i.e., for loaders, respirators are needed only at the maximum acreage and application rate).

When the maximum measured values from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs were >100 for loaders only at the minimum use scenario with a respirator (i.e., 69 acres at 1.3 lb ai/acre) and were >100 for all applicator scenarios considered (i.e., respirators are required for high application rate scenarios). MOEs were >100 for combined loader/applicators using the maximum exposure value only for the minimum acreage and typical application rate scenario with a respirator.

Using PHED data as the basis for the assessment (keeping in mind that this assessment is based on less personal protective equipment than the study), MOEs for loaders and applicators never exceeded 100 for any scenario even with the use of engineering controls.

Dermal and inhalation risks were also considered separately in the interpretation of this risk assessment. MOEs attributable to dermal exposure >100 when the maximum exposure value was considered from the chemical- and scenario-specific exposure study indicating that the MOEs attributable to inhalation exposure are the risk drivers in this assessment. The MOEs attributable to inhalation exposure are generally similar to those for combined exposures summarized above. The

same pattern emerges when PHED data are considered, MOEs attributable to dermal exposure are consistently higher and sometimes are >100 when engineering controls are used. However, inhalation MOEs never exceed 100 even if PF10 APR respirators or engineering controls are used.

To summarize, the use of terbufos 15G on sorghum is not a concern for the Agency if the loading and application events (or even when combined) are made using closed “Lock-N-Load” systems and closed cabs as monitored in the chemical- and scenario-specific exposure studies. Other exposure scenarios, using lesser levels of personal protection were also considered in this assessment based on data from PHED. The Agency has a concern for all of these scenarios.

**For The 15G Formulation on Sugar Beets:** The maximum application rate on the Federal Section 3 label is 1.96 lb ai/acre. Additionally, a typical application rate of 1.3 lb ai/acre was considered. The 15G is currently marketed by American Cyanamid only in “Lock-N-Load” packaging. The chemical- and scenario-specific study reflects this pattern. When the geometric mean values (i.e., a measure of central tendency like the values calculated with PHED) from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs for all scenarios (loaders, applicators, and combined loader/applicators) considered were >100 even if the loading and application job functions were combined. Respirators (PF =10) are, however, required for the loaders and loader/applicator maximum application rate scenarios (i.e., for loaders, respirators are needed only at the maximum acreage and application rate).

When the maximum measured values from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs were >100 for loaders only at the minimum use scenario with a respirator (i.e., 69 acres at 1.3 lb ai/acre) and were >100 for all applicator scenarios considered. MOEs were >100 for combined loader/applicators using the maximum exposure value also only for the minimum acreage and typical application rate scenario with a respirator.

Using PHED data as the basis for the assessment (keeping in mind that this assessment is based on less personal protective equipment than the study), MOEs for loaders and applicators never exceeded 100 for any scenario even with the use of engineering controls.

Dermal and inhalation risks were also considered separately in the interpretation of this risk assessment. MOEs attributable to dermal exposure >100 when the maximum exposure value was considered from the chemical- and scenario-specific exposure study indicating that the MOEs attributable to inhalation exposure are the risk drivers in this assessment. The MOEs attributable to inhalation exposure are generally similar to those for combined exposures summarized above. The same pattern emerges when PHED data are considered, MOEs attributable to dermal exposure are consistently higher and sometimes are >100 when engineering controls are used. However, inhalation MOEs never exceed 100 even if PF10 APR respirators or engineering controls are used.

To summarize, the use of terbufos 15G on corn is not a concern for the Agency if the loading and application events (or even when combined) are made using closed “Lock-N-Load” systems and closed cabs as monitored in the chemical- and scenario-specific exposure studies. Other exposure scenarios, using lesser levels of personal protection were also considered in this assessment based on data from PHED. The Agency has a concern for all of these scenarios.

#### **For the 20CR:**

**For The 20CR Formulation on Corn:** The maximum application rate on the Federal Section 3 label is 1.3 lb ai/acre while the 24C/SLN label from North Carolina allows applications up to 2.6 lb ai/acre. Additionally, a typical application rate of 1.1 lb ai/acre was considered. The 20CR is currently marketed by American Cyanamid in both bags (~30%) and “Lock-N-Load” (~70%) packaging. The chemical- and scenario-specific study reflects the open bag exposure scenario. When the geometric mean values (i.e., a measure of central tendency like the values calculated with PHED) from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs for loaders and combined loader/applicators were >100 if a PF 10 respirator is required (i.e., 24C/SLN MOEs >100 at low acreage only, MOEs>60 for high acreage). Applicator MOEs>100 without any respiratory protection (i.e., 24C/SLN MOEs also>100 even at high acreage). However, if the 15G study data are used as a surrogate, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with closed cab application if a respirator is used because the risks are of no concern for the 15G in the same scenario, the inhalation NOAEL is the same, and the dermal NOAEL (2.0 mg/kg/day) for the 20CR formulation is 6.25 times higher than the NOAEL (0.32 mg/kg/day) for the 15G formulation. Likewise, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with open cab application (i.e., based on combination of 15G and 20CR study data) if a respirator is used .

When the maximum measured values from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs were <100 for loaders and combined loader/applicators (i.e., SLN/24C label MOEs also <100). MOEs were >100 for applicators in all scenarios considered without a respirator except the high acreage SLN/24C scenario (MOE = 81.1). The high acreage 24C applicator scenario MOE>100 if a respirator is used.

Using PHED data as the basis for the assessment (keeping in mind that this assessment is based on less personal protective equipment than the study), MOEs for loaders and applicators never exceeded 100 for any scenario even with the use of engineering controls.

Dermal and inhalation risks were also considered separately in the interpretation of this risk assessment. MOEs attributable to dermal exposure >100 when the maximum exposure value was considered from the chemical- and scenario-specific exposure study indicating that the MOEs

attributable to inhalation exposure are the risk drivers in this assessment. The MOEs attributable to inhalation exposure are generally similar to those for combined exposures summarized above. The same pattern emerges when PHED data are considered, MOEs attributable to dermal exposure >100 for the low rate/low acreage scenario when engineering controls are used. However, inhalation MOEs never exceed 100 even if PF10 APR respirators or engineering controls are used.

To summarize, the use of terbufos 20CR on corn is not a concern for the Agency if the loading and application events (or even when combined) are made using closed “Lock-N-Load” systems and either open or closed cabs as monitored in the chemical- and scenario-specific exposure studies. Other exposure scenarios, using lesser levels of personal protection were also considered in this assessment based on chemical- and scenario-specific data (i.e., open bag and open cab applications) and data from PHED. The Agency has a concern for all of these scenarios.

**For The 20CR Formulation on Sorghum:** The maximum application rate on the Federal Section 3 label is 1.96 lb ai/acre. Additionally, a typical application rate of 1.3 lb ai/acre was considered. The 20CR is currently marketed by American Cyanamid in both bags (~30%) and “Lock-N-Load” (~70%) packaging. The chemical- and scenario-specific study reflects the open bag exposure scenario. When the geometric mean values (i.e., a measure of central tendency like the values calculated with PHED) from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs for loaders and combined loader/applicators were >100 if a PF 10 respirator is used except at the high application rate and acreage scenario (MOEs>80). Applicator MOEs >100 for all scenarios without a respirator. However, if the 15G study data are used as a surrogate, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with closed cab application if a respirator is used because the risks are of no concern for the 15G in the same scenario, the inhalation NOAEL is the same, and the dermal NOAEL (2.0 mg/kg/day) for the 20CR formulation is 6.25 times higher than the NOAEL (0.32 mg/kg/day) for the 15G formulation. Likewise, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with open cab application (i.e., based on combination of 15G and 20CR study data) if a respirator is used .

When the maximum measured values from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs were <100 for loaders and loader/applicators. Applicator MOEs >100 for all scenarios without a respirator.

Using PHED data as the basis for the assessment (keeping in mind that this assessment is based on less personal protective equipment than the study), MOEs for loaders and applicators never exceeded 100 for any scenario even with the use of engineering controls.

Dermal and inhalation risks were also considered separately in the interpretation of this risk assessment. MOEs attributable to dermal exposure >100 when the maximum exposure value was considered from the chemical- and scenario-specific exposure study indicating that the MOEs attributable to inhalation exposure are the risk drivers in this assessment. The MOEs attributable to inhalation exposure are generally similar to those for combined exposures summarized above. The

same pattern emerges when PHED data are considered, MOEs attributable to dermal exposure are consistently higher and sometimes are >100 when personal protective equipment or engineering controls are used. However, inhalation MOEs never exceed 100 even if PF10 APR respirators or engineering controls are used.

To summarize, the use of terbufos 20CR on sorghum is not a concern for the Agency if the loading and application events (or even when combined) are made using closed “Lock-N-Load” systems and either open or closed cabs as monitored in the chemical- and scenario-specific exposure studies. Other exposure scenarios, using lesser levels of personal protection were also considered in this assessment based on chemical- and scenario-specific data (i.e., open bag and open cab applications) and data from PHED. The Agency has a concern for all of these scenarios.

**For The 20CR Formulation on Sugar Beets:** The maximum application rate on the Federal Section 3 label is 1.96 lb ai/acre. Additionally, a typical application rate of 1.3 lb ai/acre was considered. The 20CR is currently marketed by American Cyanamid in both bags (~30%) and “Lock-N-Load” (~70%) packaging. The chemical- and scenario-specific study reflects the open bag exposure scenario. When the geometric mean values (i.e., a measure of central tendency like the values calculated with PHED) from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs for loaders and combined loader/applicators were >100 if a PF 10 respirator is used except at the high application rate and acreage scenario (MOEs>80). Applicator MOEs >100 for all scenarios without a respirator. However, if the 15G study data are used as a surrogate, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with closed cab application if a respirator is used because the risks are of no concern for the 15G in the same scenario, the inhalation NOAEL is the same, and the dermal NOAEL (2.0 mg/kg/day) for the 20CR formulation is 6.25 times higher than the NOAEL (0.32 mg/kg/day) for the 15G formulation. Likewise, the Agency has no concerns over the use of the 20CR in “Lock-N-Load” packaging (about 70% of sales) coupled with open cab application (i.e., based on combination of 15G and 20CR study data) if a respirator is used .

When the maximum measured values from the chemical- and scenario-specific study were used as the basis for the calculations, MOEs were <100 for loaders and loader/applicators. Applicator MOEs >100 for all scenarios without a respirator.

Using PHED data as the basis for the assessment (keeping in mind that this assessment is based on less personal protective equipment than the study), MOEs for loaders and applicators never exceeded 100 for any scenario even with the use of engineering controls.

Dermal and inhalation risks were also considered separately in the interpretation of this risk assessment. MOEs attributable to dermal exposure >100 when the maximum exposure value was considered from the chemical- and scenario-specific exposure study indicating that the MOEs attributable to inhalation exposure are the risk drivers in this assessment. The MOEs attributable to inhalation exposure are generally similar to those for combined exposures summarized above. The

same pattern emerges when PHED data are considered, MOEs attributable to dermal exposure are consistently higher and sometimes are >100 when personal protective equipment or engineering controls are used. However, inhalation MOEs never exceed 100 even if PF10 APR respirators or engineering controls are used.

To summarize, the use of terbufos 20CR on sugar beets is not a concern for the Agency if the loading and application events (or even when combined) are made using closed “Lock-N-Load” systems and either open or closed cabs as monitored in the chemical- and scenario-specific exposure studies. Other exposure scenarios, using lesser levels of personal protection were also considered in this assessment based on chemical- and scenario-specific data (i.e., open bag and open cab applications) and data from PHED. The Agency has a concern for all of these scenarios.

### ***iii. Residential (Homeowner) Handler Risk Summary***

No terbufos uses in the residential market are allowed by current labeling. Therefore, the Agency did not include exposure scenarios/populations for this setting in this assessment.

### ***iv. Occupational Risks From Postapplication Exposures***

The Agency did not include exposure scenarios/populations in this assessment because of when terbufos is typically applied in the growing season and the way that terbufos is applied (i.e., granulars that are soil incorporated).

### ***v. Residential Risks From Postapplication Exposures***

No terbufos uses in the residential market are allowed by current labeling. Therefore, the Agency did not include exposure scenarios/populations for this setting in this assessment. The Agency also does not expect significant drift or other migration of agriculturally used terbufos into the residential setting because of the way that terbufos is applied (i.e., granulars that are soil incorporated).

### ***vi. Incident reports***

The incident report completed for this assessment is not included in this document. The report has been developed under a separate memo by Dr. Jerome Blondell of the Office of Pesticide Programs. This report as well as the results of this risk assessment are considered in the overall risk assessment for terbufos.

### ***vii. Overall risk summary***

The Agency risk assessment for terbufos has been significantly revised because the registrant has submitted two formulation-specific dermal toxicity studies and also two chemical- and scenario-specific exposure studies that have been used in the risk assessment (i.e., dermal toxicity studies on the 15G and 20CR formulations and exposure studies on the 15G in “Lock-N-Load” packaging with closed cab application and on the 20CR in bags with open cab application). These exposure data represent the best source of data currently available to the Agency for completing an assessment for terbufos as the data are of high quality and are intended to be specific for the scenarios being

The registrant used the following characteristics to calculate the impact of each group: the number of people in the group, the number of people in the group who are affected by the group, and the number of people in the group who are affected by the group.

confidentiality of the information provided in this document is not guaranteed. The information provided in this document is not intended to be used for any purpose other than the purpose for which it was provided.

## **APPENDIX A**

# **OCCUPATIONAL HANDLER RISK ASSESSMENT FOR TERBUFOS**

Appendix A/Table 1: Sources of Exposure Data Used In The Occupational Terbufos Handler Exposure And Risk Calculations

Exposure Scenario (Number)	Data Source	Standard Assumptions (8-hr work day)	Comments
Mixer/Loader Descriptors			
Loading Granular Formulations (1a)	PHED V1.1	69 to 213 acres for tractor drawn spreaders for most crops	<p><b>Baseline:</b> Low confidence in dermal and hand data (due to low hand replicates). High confidence in inhalation data. No protection factors were needed to define the unit exposure values.</p> <p><b>PPE:</b> Monitoring data for each dermal scenario were available. For the single layer clothing with gloves scenario, the same dermal and inhalation data were used as for the baseline with hand exposure data that were monitored with gloves (considered medium confidence due to poor data quality). For the double layer clothing with gloves scenario, monitoring data were available (considered low confidence based on insufficient data). A 90 percent protection factor was applied to account for the use of a respirator.</p> <p><b>Engineering Controls:</b> A 98 percent protection factor was applied to the baseline data to account for the use of an engineering control (e.g., closed loading system).</p>
Loading 15G Granular Formulation (1b)	MRID 447933-01	69 to 213 acres for tractor drawn spreaders for most crops	15 replicates monitored using “Loack-N-Load” packaging, double layer clothing, chemical-resistant gloves, all data are considered acceptable based on PHED grading criteria
Loading 20CR Granular Formulation (1c)	MRID 447933-01	69 to 213 acres for tractor drawn spreaders for most crops	15 replicates monitored using open bag packaging, double layer clothing, chemical-resistant gloves, all data are considered acceptable based on PHED grading criteria
Applicator Descriptors			
Applying Granulars with a Tractor Drawn Spreader (2a)	PHED V1.1	69 to 213 acres for tractor drawn spreaders for most crops	<p><b>Baseline:</b> Low confidence in hand, dermal, and inhalation data. No protection factors were required to define the unit exposure values.</p> <p><b>PPE:</b> As appropriate, the same dermal, hand, and inhalation data are used as for the baseline coupled with a 50% protection factor to account for an additional layer of clothing, a 90% protection factor to account for the use of chemical resistant gloves, and a 90% protection factor to account for the use of a respirator.</p> <p><b>Engineering Controls:</b> High confidence in hand, dermal, and inhalation data. No protection factors were required to define the unit exposure values</p>
Applying 15G Granular Formulation (2b)	MRID 447933-01	69 to 213 acres for tractor drawn spreaders for most crops	15 replicates monitored using closed cab tractors (all but 2, those excluded from analysis), double layer clothing, chemical-resistant gloves, all data are considered acceptable based on PHED grading criteria
Applying 20CR Granular Formulation (2c)	MRID 447933-01	69 to 213 acres for tractor drawn spreaders for most crops	15 replicates monitored using open cab tractors, double layer clothing, chemical-resistant gloves, all data are considered acceptable based on PHED grading criteria

a All *Standard Assumptions* are based on an 8-hour work day as estimated by the Agency.

b All handler exposure assessments in this document are based on the "Best Available" data as defined by the PHED SOP for meeting Subdivision U Guidelines (i.e.,

completing exposure assessments). Best available grades are assigned to data as follows: matrices with A and B grade data (i.e., Acceptable Grade Data) and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality (i.e., All Grade Data) and number of replicates. High quality data with a protection factor take precedence over low quality data with no protection factor. Generic data confidence categories are assigned as follows:

High = grades A and B and 15 or more replicates per body part

Medium = grades A, B, and C and 15 or more replicates per body part

Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates.

- c **PHED grading criteria do not reflect overall quality of the reliability of the assessment. Sources of the exposure factors should also be considered in the risk management decision.**

APPENDIX A/TABLE 2: INPUT PARAMETERS FOR TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS													
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	EXPOSURE FACTORS		DERMAL UNIT EXPOSURES (mg/lb ai)					INHALATION UNIT EXPOSURES (ug/lb ai)			
			RATE	ACRES OR GALLONS	BASELINE	MIN PPE	MAX PPE	ENGINEERING CONTROL	EC & PPE USE	NONE	MASK (PF5) RESPIRATOR	OV (PF10) RESPIRATOR	ENGINEERING CONTROL
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	1.1	69	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			1.3	180	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			1.3	213	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			2.6	69	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			2.6	213	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
		Sugar Beets	1.3	69	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			1.96	130	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			1.96	213	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
		Sorghum	1.3	69	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			1.96	130	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
			1.96	213	0.0084	0.0069	0.0034	0.000168	None	1.7	0.34	0.17	0.034
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	1.1	69	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			1.3	180	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			1.3	213	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			2.6	69	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			2.6	213	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
		Sugar Beets	1.3	69	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			1.96	130	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			1.96	213	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
		Sorghum	1.3	69	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			1.96	130	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201
			1.96	213	0.0099	0.0072	0.0042	0.0021	None	1.2	0.24	0.12	0.2201

APPENDIX A/TABLE 2: INPUT PARAMETERS FOR TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS													
CHEMICAL-SPECIFIC DATA USED FOR ASSESSMENT		CROP TYPE OR TARGET	EXPOSURE FACTORS		DERMAL UNIT EXPOSURES (mg/lb ai)			INHALATION UNIT EXPOSURES (mg/lb ai)					
					MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
			RATE	ACRES OR GALLONS									
1b	Loading of 15 G Formulation (All values measured using "Lock-n-load systems, apron used instead of coveralls)	Corn	1.1	69	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			1.3	180	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			1.3	213	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			2.6	69	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			2.6	213	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
		Sugar Beets	1.3	69	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			1.96	130	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			1.96	213	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
		Sorghum	1.3	69	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			1.96	130	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
			1.96	213	1.21e-05	5.2e-05	3.61e-04	5.28e-07	7.84e-06	6.50e-05	5.28e-08	7.84e-07	6.50e-06
1c	Loading of 20CR Formulation (All values measured using "Lock-n-load systems, apron used instead of coveralls)	Corn	1.1	69	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			1.3	180	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			1.3	213	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			2.6	69	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			2.6	213	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
		Sugar Beets	1.3	69	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			1.96	130	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			1.96	213	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
		Sorghum	1.3	69	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			1.96	130	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05
			1.96	213	1.00e-05	3.69e-05	1.6e-04	4.16e-06	6.81e-05	3.24e-04	4.16e-07	6.81e-06	3.24e-05

APPENDIX A/TABLE 2: INPUT PARAMETERS FOR TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS													
2b	Application of 15 G Formulation (All values measured using open cab tractors)	Corn	1.1	69	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			1.3	180	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			1.3	213	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			2.6	69	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			2.6	213	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
		Sugar Beets	1.3	69	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			1.96	130	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			1.96	213	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
		Sorghum	1.3	69	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			1.96	130	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
			1.96	213	7.32e-06	3.51e-05	1.65e-04	4.25e-07	2.43e-06	2.04e-05	4.25e-08	2.43e-07	2.04e-06
2c	Application of 20 CR Formulation (All values measured using open cab tractors)	Corn	1.1	69	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			1.3	180	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			1.3	213	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			2.6	69	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			2.6	213	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
		Sugar Beets	1.3	69	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			1.96	130	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			1.96	213	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
		Sorghum	1.3	69	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			1.96	130	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07
			1.96	213	9.58e-06	1.59e-05	3.88e-05	5.92e-07	1.26e-06	5.39e-06	5.92e-08	1.26e-07	5.39e-07

APPENDIX A/TABLE 3: TERBUFOS OCCUPATIONAL HANDLER EXPOSURE CALCULATIONS USING DATA FROM MRID 447933-01 FOR 15G FORMULATION											
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DAILY DERMAL EXPOSURES			DAILY INHALATION EXPOSURES					
			(mg/day)			(mg/day)					
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
1b	Loading of 15 G Formulation (All values measured using "Lock-n-load systems, apron used instead of coveralls)	Corn	9.18e-04	3.95e-03	2.74e-02	4.01e-05	5.95e-04	4.93e-03	4.01e-06	5.95e-05	4.93e-04
			2.83e-03	1.22e-02	8.45e-02	1.24e-04	1.83e-03	1.52e-02	1.24e-05	1.83e-04	1.52e-03
			3.35e-03	1.44e-02	1.00e-01	1.46e-04	2.17e-03	1.80e-02	1.46e-05	2.17e-04	1.80e-03
			2.17e-03	9.33e-03	6.48e-02	9.47e-05	1.41e-03	1.17e-02	9.47e-06	1.41e-04	1.17e-03
			6.70e-03	2.88e-02	2.00e-01	2.92e-04	4.34e-03	3.60e-02	2.92e-05	4.34e-04	3.60e-03
		Sugar Beets	1.09e-03	4.66e-03	3.24e-02	4.74e-05	7.03e-04	5.83e-03	4.74e-06	7.03e-05	5.83e-04
			3.08e-03	1.33e-02	9.20e-02	1.35e-04	2.00e-03	1.66e-02	1.35e-05	2.00e-04	1.66e-03
			5.05e-03	2.17e-02	1.51e-01	2.20e-04	3.27e-03	2.71e-02	2.20e-05	3.27e-04	2.71e-03
		Sorghum	1.09e-03	4.66e-03	3.24e-02	4.74e-05	7.03e-04	5.83e-03	4.74e-06	7.03e-05	5.83e-04
			3.08e-03	1.33e-02	9.20e-02	1.35e-04	2.00e-03	1.66e-02	1.35e-05	2.00e-04	1.66e-03
			5.05e-03	2.17e-02	1.51e-01	2.20e-04	3.27e-03	2.71e-02	2.20e-05	3.27e-04	2.71e-03
2b	Application of 15 G Formulation (All values measured using closed cab tractors)	Corn	5.56e-04	2.66e-03	1.25e-02	3.23e-05	1.84e-04	1.55e-03	3.23e-06	1.84e-05	1.55e-04
			1.71e-03	8.21e-03	3.86e-02	9.95e-05	5.69e-04	4.77e-03	9.95e-06	5.69e-05	4.77e-04
			2.03e-03	9.72e-03	4.57e-02	1.18e-04	6.73e-04	5.65e-03	1.18e-05	6.73e-05	5.65e-04
			1.31e-03	6.30e-03	2.96e-02	7.62e-05	4.36e-04	3.66e-03	7.62e-06	4.36e-05	3.66e-04
			4.05e-03	1.94e-02	9.14e-02	2.35e-04	1.35e-03	1.13e-02	2.35e-05	1.35e-04	1.13e-03
		Sugar Beets	6.57e-04	3.15e-03	1.48e-02	3.81e-05	2.18e-04	1.83e-03	3.81e-06	2.18e-05	1.83e-04
			1.87e-03	8.94e-03	4.20e-02	1.08e-04	6.19e-04	5.20e-03	1.08e-05	6.19e-05	5.20e-04
			3.06e-03	1.47e-02	6.89e-02	1.77e-04	1.01e-03	8.52e-03	1.77e-05	1.01e-04	8.52e-04
		Sorghum	6.57e-04	3.15e-03	1.48e-02	3.81e-05	2.18e-04	1.83e-03	3.81e-06	2.18e-05	1.83e-04
			1.87e-03	8.94e-03	4.20e-02	1.08e-04	6.19e-04	5.20e-03	1.08e-05	6.19e-05	5.20e-04
			3.06e-03	1.47e-02	6.89e-02	1.77e-04	1.01e-03	8.52e-03	1.77e-05	1.01e-04	8.52e-04

APPENDIX A/TABLE 3: TERBUFOS OCCUPATIONAL HANDLER EXPOSURE CALCULATIONS USING DATA FROM MRID 447933-01 FOR 15G FORMULATION											
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DERMAL DOSE LEVELS (mg/kg/day)			DAILY INHALATION DOSE (mg/kg/day)					
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
1b	Loading of 15 G Formulation (All values measured using "Lock-n-load systems, apron used instead of coveralls)	Corn	1.31e-05	5.64e-05	3.91e-04	5.73e-07	8.50e-06	7.05e-05	5.73e-08	8.50e-07	7.05e-06
			4.04e-05	1.74e-04	1.21e-03	1.77e-06	2.62e-05	2.17e-04	1.77e-07	2.62e-06	2.17e-05
			4.79e-05	2.06e-04	1.43e-03	2.09e-06	3.10e-05	2.57e-04	2.09e-07	3.10e-06	2.57e-05
			3.10e-05	1.33e-04	9.25e-04	1.35e-06	2.01e-05	1.67e-04	1.35e-07	2.01e-06	1.67e-05
			9.57e-05	4.11e-04	2.86e-03	4.18e-06	6.20e-05	5.14e-04	4.18e-07	6.20e-06	5.14e-05
		Sugar Beets	1.55e-05	6.66e-05	4.63e-04	6.77e-07	1.00e-05	8.33e-05	6.77e-08	1.00e-06	8.33e-06
			4.40e-05	1.89e-04	1.31e-03	1.92e-06	2.85e-05	2.37e-04	1.92e-07	2.85e-06	2.37e-05
			7.22e-05	3.10e-04	2.15e-03	3.15e-06	4.68e-05	3.88e-04	3.15e-07	4.68e-06	3.88e-05
		Sorghum	1.55e-05	6.66e-05	4.63e-04	6.77e-07	1.00e-05	8.33e-05	6.77e-08	1.00e-06	8.33e-06
			4.40e-05	1.89e-04	1.31e-03	1.92e-06	2.85e-05	2.37e-04	1.92e-07	2.85e-06	2.37e-05
			7.22e-05	3.10e-04	2.15e-03	3.15e-06	4.68e-05	3.88e-04	3.15e-07	4.68e-06	3.88e-05
2b	Application of 15 G Formulation (All values measured using open cab tractors)	Corn	7.94e-06	3.81e-05	1.79e-04	4.61e-07	2.63e-06	2.21e-05	4.61e-08	2.63e-07	2.21e-06
			2.45e-05	1.17e-04	5.52e-04	1.42e-06	8.12e-06	6.82e-05	1.42e-07	8.12e-07	6.82e-06
			2.90e-05	1.39e-04	6.53e-04	1.68e-06	9.61e-06	8.07e-05	1.68e-07	9.61e-07	8.07e-06
			1.88e-05	9.00e-05	4.23e-04	1.09e-06	6.23e-06	5.23e-05	1.09e-07	6.23e-07	5.23e-06
			5.79e-05	2.78e-04	1.31e-03	3.36e-06	1.92e-05	1.61e-04	3.36e-07	1.92e-06	1.61e-05
		Sugar Beets	9.38e-06	4.50e-05	2.11e-04	5.45e-07	3.11e-06	2.61e-05	5.45e-08	3.11e-07	2.61e-06
			2.66e-05	1.28e-04	6.01e-04	1.55e-06	8.85e-06	7.43e-05	1.55e-07	8.85e-07	7.43e-06
			4.37e-05	2.09e-04	9.84e-04	2.53e-06	1.45e-05	1.22e-04	2.53e-07	1.45e-06	1.22e-05
		Sorghum	9.38e-06	4.50e-05	2.11e-04	5.45e-07	3.11e-06	2.61e-05	5.45e-08	3.11e-07	2.61e-06
			2.66e-05	1.28e-04	6.01e-04	1.55e-06	8.85e-06	7.43e-05	1.55e-07	8.85e-07	7.43e-06
			4.37e-05	2.09e-04	9.84e-04	2.53e-06	1.45e-05	1.22e-04	2.53e-07	1.45e-06	1.22e-05

APPENDIX A/TABLE 4: TERBUFOS OCCUPATIONAL HANDLER RISK CALCULATIONS USING DATA FROM MRID 447933-01 FOR 15G FORMULATION											
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DERMAL MOEs			INHALATION MOEs					
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
1b	Loading of 15 G Formulation (All values measured using "Lock-n-load systems, apron used instead of coveralls)	Corn	24390.5	5675.5	817.5	6113.5	411.7	49.7	61135.1	4117.3	496.6
			7911.3	1840.9	265.2	1983.0	133.5	16.1	19829.7	1335.5	161.1
			6685.6	1555.7	224.1	1675.7	112.9	13.6	16757.5	1128.6	136.1
			10319.1	2401.2	345.9	2586.5	174.2	21.0	25864.8	1741.9	210.1
			3342.8	777.8	112.0	837.9	56.4	6.8	8378.7	564.3	68.1
		Sugar Beets	20638.1	4802.3	691.7	5173.0	348.4	42.0	51729.7	3483.8	420.2
			7265.5	1690.6	243.5	1821.1	122.6	14.8	18211.0	1226.5	147.9
			4434.3	1031.8	148.6	1111.5	74.9	9.0	11114.7	748.5	90.3
		Sorghum	20638.1	4802.3	691.7	5173.0	348.4	42.0	51729.7	3483.8	420.2
			7265.5	1690.6	243.5	1821.1	122.6	14.8	18211.0	1226.5	147.9
			4434.3	1031.8	148.6	1111.5	74.9	9.0	11114.7	748.5	90.3
2b	Application of 15 G Formulation (All values measured using closed cab tractors)	Corn	40317.6	8408.1	1788.6	7595.1	1328.4	158.2	75951.3	13283.7	1582.3
			13077.4	2727.3	580.2	2463.5	430.9	51.3	24635.5	4308.7	513.2
			11051.3	2304.7	490.3	2081.9	364.1	43.4	20818.7	3641.1	433.7
			17057.5	3557.3	756.7	3213.3	562.0	66.9	32133.3	5620.0	669.4
			5525.7	1152.4	245.1	1040.9	182.1	21.7	10409.4	1820.6	216.9
		Sugar Beets	34114.9	7114.6	1513.5	6426.7	1124.0	133.9	64266.5	11240.0	1338.9
			12009.8	2504.6	532.8	2262.4	395.7	47.1	22624.4	3956.9	471.3
			7330.0	1528.6	325.2	1380.8	241.5	28.8	13808.3	2415.0	287.7
		Sorghum	34114.9	7114.6	1513.5	6426.7	1124.0	133.9	64266.5	11240.0	1338.9
			12009.8	2504.6	532.8	2262.4	395.7	47.1	22624.4	3956.9	471.3
			7330.0	1528.6	325.2	1380.8	241.5	28.8	13808.3	2415.0	287.7

APPENDIX A/TABLE 4: TERBUFOS OCCUPATIONAL HANDLER RISK CALCULATIONS USING DATA FROM MRID 447933-01 FOR 15G FORMULATION									
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	COMBINED MOEs WITH NO RESPIRATOR			COMBINED MOEs WITH PF 10 RESPIRATOR			
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	
1b	Loading of 15 G Formulation (All values measured using "Lock-n-load systems, apron used instead of coveralls)	Corn	4888.3	383.9	46.8	17434.7	2386.2	308.9	
			1585.6	124.5	15.2	5655.1	774.0	100.2	
			1339.9	105.2	12.8	4779.0	654.1	84.7	
			2068.1	162.4	19.8	7376.2	1009.5	130.7	
			670.0	52.6	6.4	2389.5	327.0	42.3	
		Sugar Beets	4136.2	324.8	39.6	14752.5	2019.1	261.4	
			1456.1	114.4	13.9	5193.5	710.8	92.0	
			888.7	69.8	8.5	3169.7	433.8	56.2	
		Sorghum	4136.2	324.8	39.6	14752.5	2019.1	261.4	
			1456.1	114.4	13.9	5193.5	710.8	92.0	
			888.7	69.8	8.5	3169.7	433.8	56.2	
2b	Application of 15 G Formulation (All values measured using closed cab tractors)	Corn	6391.2	1147.1	145.4	26337.0	5149.0	839.6	
			2073.0	372.1	47.2	8542.7	1670.1	272.3	
			1751.9	314.4	39.8	7219.1	1411.4	230.1	
			2703.9	485.3	61.5	11142.6	2178.4	355.2	
			875.9	157.2	19.9	3609.6	705.7	115.1	
		Sugar Beets	5407.9	970.7	123.0	22285.2	4356.8	710.4	
			1903.8	341.7	43.3	7845.3	1533.8	250.1	
			1161.9	208.6	26.4	4788.2	936.1	152.6	
		Sorghum	5407.9	970.7	123.0	22285.2	4356.8	710.4	
			1903.8	341.7	43.3	7845.3	1533.8	250.1	
			1161.9	208.6	26.4	4788.2	936.1	152.6	
1b & 2b	Loading & Application of 15 G Formulation	Corn	2769.8	287.6	35.4	10490.3	1630.6	225.8	
			898.4	93.3	11.5	3402.6	528.9	73.3	
			759.2	78.8	9.7	2875.5	446.9	61.9	
			1171.8	121.7	15.0	4438.2	689.8	95.5	
			379.6	39.4	4.9	1437.7	223.5	31.0	
		Sugar Beets	2343.7	243.4	30.0	8876.4	1379.7	191.1	
			825.1	85.7	10.5	3124.9	485.7	67.3	
			503.6	52.3	6.4	1907.2	296.4	41.1	
		Sorghum	2343.7	243.4	30.0	8876.4	1379.7	191.1	
			825.1	85.7	10.5	3124.9	485.7	67.3	
			503.6	52.3	6.4	1907.2	296.4	41.1	

APPENDIX A/TABLE 5: TERBUPHOS OCCUPATIONAL HANDLER EXPOSURE CALCULATIONS USING DATA FROM MRID 447933-01 FOR 20 CR FORMULATION											
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DAILY DERMAL EXPOSURES (mg/day)			DAILY INHALATION EXPOSURES (mg/day)					
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
1b	Loading of 20 CR Formulation (All values measured using open-bags, apron used instead of coveralls)	Corn	7.59e-04	2.80e-03	1.21e-02	3.16e-04	5.17e-03	2.46e-02	3.16e-05	5.17e-04	2.46e-03
			2.34e-03	8.63e-03	3.74e-02	9.73e-04	1.59e-02	7.58e-02	9.73e-05	1.59e-03	7.58e-03
			2.77e-03	1.02e-02	4.43e-02	1.15e-03	1.89e-02	8.97e-02	1.15e-04	1.89e-03	8.97e-03
			1.79e-03	6.62e-03	2.87e-02	7.46e-04	1.22e-02	5.81e-02	7.46e-05	1.22e-03	5.81e-03
			5.54e-03	2.04e-02	8.86e-02	2.30e-03	3.77e-02	1.79e-01	2.30e-04	3.77e-03	1.79e-02
		Sugar Beets	8.97e-04	3.31e-03	1.44e-02	3.73e-04	6.11e-03	2.91e-02	3.73e-05	6.11e-04	2.91e-03
			2.55e-03	9.40e-03	4.08e-02	1.06e-03	1.74e-02	8.26e-02	1.06e-04	1.74e-03	8.26e-03
			4.17e-03	1.54e-02	6.68e-02	1.74e-03	2.84e-02	1.35e-01	1.74e-04	2.84e-03	1.35e-02
		Sorghum	8.97e-04	3.31e-03	1.44e-02	3.73e-04	6.11e-03	2.91e-02	3.73e-05	6.11e-04	2.91e-03
			2.55e-03	9.40e-03	4.08e-02	1.06e-03	1.74e-02	8.26e-02	1.06e-04	1.74e-03	8.26e-03
			4.17e-03	1.54e-02	6.68e-02	1.74e-03	2.84e-02	1.35e-01	1.74e-04	2.84e-03	1.35e-02
2b	Application of 20 CR Formulation (All values measured using open cab tractors)	Corn	7.27e-04	1.21e-03	2.94e-03	4.49e-05	9.56e-05	4.09e-04	4.49e-06	9.56e-06	4.09e-05
			2.24e-03	3.72e-03	9.08e-03	1.39e-04	2.95e-04	1.26e-03	1.39e-05	2.95e-05	1.26e-04
			2.65e-03	4.40e-03	1.07e-02	1.64e-04	3.49e-04	1.49e-03	1.64e-05	3.49e-05	1.49e-04
			1.72e-03	2.85e-03	6.96e-03	1.06e-04	2.26e-04	9.67e-04	1.06e-05	2.26e-05	9.67e-05
			5.31e-03	8.81e-03	2.15e-02	3.28e-04	6.98e-04	2.98e-03	3.28e-05	6.98e-05	2.98e-04
		Sugar Beets	8.59e-04	1.43e-03	3.48e-03	5.31e-05	1.13e-04	4.83e-04	5.31e-06	1.13e-05	4.83e-05
			2.44e-03	4.05e-03	9.89e-03	1.51e-04	3.21e-04	1.37e-03	1.51e-05	3.21e-05	1.37e-04
			4.00e-03	6.64e-03	1.62e-02	2.47e-04	5.26e-04	2.25e-03	2.47e-05	5.26e-05	2.25e-04
		Sorghum	8.59e-04	1.43e-03	3.48e-03	5.31e-05	1.13e-04	4.83e-04	5.31e-06	1.13e-05	4.83e-05
			2.44e-03	4.05e-03	9.89e-03	1.51e-04	3.21e-04	1.37e-03	1.51e-05	3.21e-05	1.37e-04
			4.00e-03	6.64e-03	1.62e-02	2.47e-04	5.26e-04	2.25e-03	2.47e-05	5.26e-05	2.25e-04

SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DERMAL DOSE LEVELS (mg/kg/day)			DAILY INHALATION DOSE (mg/kg/day)					
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
1b	Loading of 20 CR Formulation (All values measured using open-bags, apron used instead of coveralls)	Corn	1.08e-05	4.00e-05	1.73e-04	4.51e-06	7.38e-05	3.51e-04	4.51e-07	7.38e-06	3.51e-05
			3.34e-05	1.23e-04	5.35e-04	1.39e-05	2.28e-04	1.08e-03	1.39e-06	2.28e-05	1.08e-04
			3.96e-05	1.46e-04	6.33e-04	1.65e-05	2.69e-04	1.28e-03	1.65e-06	2.69e-05	1.28e-04
			2.56e-05	9.46e-05	4.10e-04	1.07e-05	1.75e-04	8.30e-04	1.07e-06	1.75e-05	8.30e-05
			7.91e-05	2.92e-04	1.27e-03	3.29e-05	5.39e-04	2.56e-03	3.29e-06	5.39e-05	2.56e-04
		Sugar Beets	1.28e-05	4.73e-05	2.05e-04	5.33e-06	8.73e-05	4.15e-04	5.33e-07	8.73e-06	4.15e-05
			3.64e-05	1.34e-04	5.82e-04	1.51e-05	2.48e-04	1.18e-03	1.51e-06	2.48e-05	1.18e-04
			5.96e-05	2.20e-04	9.54e-04	2.48e-05	4.06e-04	1.93e-03	2.48e-06	4.06e-05	1.93e-04
		Sorghum	1.28e-05	4.73e-05	2.05e-04	5.33e-06	8.73e-05	4.15e-04	5.33e-07	8.73e-06	4.15e-05
			3.64e-05	1.34e-04	5.82e-04	1.51e-05	2.48e-04	1.18e-03	1.51e-06	2.48e-05	1.18e-04
			5.96e-05	2.20e-04	9.54e-04	2.48e-05	4.06e-04	1.93e-03	2.48e-06	4.06e-05	1.93e-04
2b	Application of 20 CR Formulation (All values measured using open cab tractors)	Corn	1.04e-05	1.72e-05	4.21e-05	6.42e-07	1.37e-06	5.84e-06	6.42e-08	1.37e-07	5.84e-07
			3.20e-05	5.32e-05	1.30e-04	1.98e-06	4.21e-06	1.80e-05	1.98e-07	4.21e-07	1.80e-06
			3.79e-05	6.29e-05	1.53e-04	2.34e-06	4.98e-06	2.13e-05	2.34e-07	4.98e-07	2.13e-06
			2.46e-05	4.07e-05	9.94e-05	1.52e-06	3.23e-06	1.38e-05	1.52e-07	3.23e-07	1.38e-06
			7.58e-05	1.26e-04	3.07e-04	4.68e-06	9.97e-06	4.26e-05	4.68e-07	9.97e-07	4.26e-06
		Sugar Beets	1.23e-05	2.04e-05	4.97e-05	7.59e-07	1.61e-06	6.91e-06	7.59e-08	1.61e-07	6.91e-07
			3.49e-05	5.79e-05	1.41e-04	2.15e-06	4.59e-06	1.96e-05	2.15e-07	4.59e-07	1.96e-06
			5.71e-05	9.48e-05	2.31e-04	3.53e-06	7.51e-06	3.21e-05	3.53e-07	7.51e-07	3.21e-06
		Sorghum	1.23e-05	2.04e-05	4.97e-05	7.59e-07	1.61e-06	6.91e-06	7.59e-08	1.61e-07	6.91e-07
			3.49e-05	5.79e-05	1.41e-04	2.15e-06	4.59e-06	1.96e-05	2.15e-07	4.59e-07	1.96e-06
			5.71e-05	9.48e-05	2.31e-04	3.53e-06	7.51e-06	3.21e-05	3.53e-07	7.51e-07	3.21e-06

APPENDIX A/TABLE 6: TERBUFOS OCCUPATIONAL HANDLER RISK CALCULATIONS USING DATA FROM MRID 447933-01 FOR 20 CR FORMULATION											
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DERMAL MOEs			INHALATION MOEs					
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	NONE Minimum Value	NONE Geo. Mean	NONE Maximum Value	PF 10 Resp. Minimum Value	PF 10 Resp. Geo. Mean	PF 10 Resp. Maximum Value
1b	Loading of 20 CR Formulation (All values measured using open-bags, apron used instead of coveralls)	Corn	184453.2	49987.3	11528.3	775.9	47.4	10.0	7759.5	474.0	99.6
			59829.1	16213.8	3739.3	251.7	15.4	3.2	2516.8	153.7	32.3
			50559.8	13701.8	3160.0	212.7	13.0	2.7	2126.9	129.9	27.3
			78037.9	21148.5	4877.4	328.3	20.1	4.2	3282.8	200.5	42.2
			25279.9	6850.9	1580.0	106.3	6.5	1.4	1063.5	65.0	13.7
		Sugar Beets	156075.8	42297.0	9754.7	656.6	40.1	8.4	6565.7	401.1	84.3
			54945.1	14890.3	3434.1	231.1	14.1	3.0	2311.4	141.2	29.7
			33534.5	9088.0	2095.9	141.1	8.6	1.8	1410.7	86.2	18.1
		Sorghum	156075.8	42297.0	9754.7	656.6	40.1	8.4	6565.7	401.1	84.3
			54945.1	14890.3	3434.1	231.1	14.1	3.0	2311.4	141.2	29.7
			33534.5	9088.0	2095.9	141.1	8.6	1.8	1410.7	86.2	18.1
2b	Application of 20 CR Formulation (All values measured using open cab tractors)	Corn	192539.9	116008.3	47539.5	5452.6	2561.9	598.9	54525.9	25618.5	5988.7
			62452.0	37628.3	15419.9	1768.6	831.0	194.3	17686.0	8309.6	1942.5
			52776.4	31798.6	13030.9	1494.6	702.2	164.2	14945.9	7022.2	1641.6
			81459.2	49080.4	20112.9	2306.9	1083.9	253.4	23068.6	10838.6	2533.7
			26388.2	15899.3	6515.4	747.3	351.1	82.1	7472.9	3511.1	820.8
		Sugar Beets	162918.4	98160.9	40225.7	4613.7	2167.7	506.7	46137.3	21677.2	5067.4
			57353.9	34556.6	14161.1	1624.2	763.1	178.4	16242.2	7631.3	1783.9
			35004.7	21090.9	8642.9	991.3	465.8	108.9	9913.1	4657.6	1088.8
		Sorghum	162918.4	98160.9	40225.7	4613.7	2167.7	506.7	46137.3	21677.2	5067.4
			57353.9	34556.6	14161.1	1624.2	763.1	178.4	16242.2	7631.3	1783.9
			35004.7	21090.9	8642.9	991.3	465.8	108.9	9913.1	4657.6	1088.8

SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	COMBINED MOEs WITH NO RESPIRATOR			COMBINED MOEs WITH PF 10 RESPIRATOR		
			MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value	MAX PPE Minimum Value	MAX PPE Geo. Mean	MAX PPE Maximum Value
1b	Loading of 20 CR Formulation (All values measured using open-bags, apron used instead of coveralls)	Corn	772.7	47.4	10.0	7446.2	469.5	98.8
			250.6	15.4	3.2	2415.2	152.3	32.0
			211.8	13.0	2.7	2041.1	128.7	27.1
			326.9	20.0	4.2	3150.3	198.7	41.8
			105.9	6.5	1.4	1020.5	64.4	13.5
		Sugar Beets	653.8	40.1	8.4	6300.6	397.3	83.6
			230.2	14.1	3.0	2218.1	139.9	29.4
			140.5	8.6	1.8	1353.8	85.4	18.0
		Sorghum	653.8	40.1	8.4	6300.6	397.3	83.6
			230.2	14.1	3.0	2218.1	139.9	29.4
			140.5	8.6	1.8	1353.8	85.4	18.0
2b	Application of 20 CR Formulation (All values measured using open cab tractors)	Corn	5302.4	2506.5	591.4	42492.4	20984.4	5318.7
			1719.9	813.0	191.8	13782.8	6806.5	1725.2
			1453.4	687.0	162.1	11647.4	5752.0	1457.9
			2243.3	1060.4	250.2	17977.5	8878.0	2250.2
			726.7	343.5	81.1	5823.7	2876.0	728.9
		Sugar Beets	4486.7	2120.9	500.4	35955.1	17756.1	4500.5
			1579.5	746.6	176.2	12657.7	6250.9	1584.3
			964.0	455.7	107.5	7725.3	3815.1	967.0
		Sorghum	4486.7	2120.9	500.4	35955.1	17756.1	4500.5
			1579.5	746.6	176.2	12657.7	6250.9	1584.3
			964.0	455.7	107.5	7725.3	3815.1	967.0
1b & 2b	Loading & Application of 20 CR Formulation	Corn	674.4	46.5	9.8	6335.9	459.3	97.0
			218.8	15.1	3.2	2055.1	149.0	31.5
			184.9	12.7	2.7	1736.7	125.9	26.6
			285.3	19.7	4.1	2680.6	194.3	41.0
			92.4	6.4	1.3	868.4	62.9	13.3
		Sugar Beets	570.7	39.3	8.3	5361.2	388.6	82.1
			200.9	13.8	2.9	1887.3	136.8	28.9
			122.6	8.5	1.8	1151.9	83.5	17.6
		Sorghum	570.7	39.3	8.3	5361.2	388.6	82.1
			200.9	13.8	2.9	1887.3	136.8	28.9
			122.6	8.5	1.8	1151.9	83.5	17.6

APPENDIX A/TABLE 7: TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS AT THE BASELINE PROTECTION LEVEL USING PHED DATA												
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DAILY EXPOSURE		DAILY DOSE			DERMAL MOEs		INHAL. MOE	COMBINED MOE	
			DERMAL (mg/day)	INHALAT. (mg/day)	15 G DERMAL (mg/kg/day)	20 CR DERMAL (mg/kg/day)	INHAL. (mg/kg/day)	15 G	20 CR		15 G	20 CR
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	6.38e-01	1.29e-01	9.11e-03	9.11e-03	1.84e-03	35.1	219.6	1.9	1.8	1.9
			1.97e+00	3.98e-01	2.81e-02	2.81e-02	5.68e-03	11.4	71.2	0.6	0.6	0.6
			2.33e+00	4.71e-01	3.32e-02	3.32e-02	6.72e-03	9.6	60.2	0.5	0.5	0.5
			1.51e+00	3.05e-01	2.15e-02	2.15e-02	4.36e-03	14.9	92.9	0.8	0.8	0.8
			4.65e+00	9.41e-01	6.65e-02	6.65e-02	1.34e-02	4.8	30.1	0.3	0.2	0.3
		Sugar Beets	7.53e-01	1.52e-01	1.08e-02	1.08e-02	2.18e-03	29.7	185.8	1.6	1.5	1.6
			2.14e+00	4.33e-01	3.06e-02	3.06e-02	6.19e-03	10.5	65.4	0.6	0.5	0.6
			3.51e+00	7.10e-01	5.01e-02	5.01e-02	1.01e-02	6.4	39.9	0.3	0.3	0.3
		Sorghum	7.53e-01	1.52e-01	1.08e-02	1.08e-02	2.18e-03	29.7	185.8	1.6	1.5	1.6
			2.14e+00	4.33e-01	3.06e-02	3.06e-02	6.19e-03	10.5	65.4	0.6	0.5	0.6
			3.51e+00	7.10e-01	5.01e-02	5.01e-02	1.01e-02	6.4	39.9	0.3	0.3	0.3
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	7.51e-01	9.11e-02	1.07e-02	1.07e-02	1.30e-03	29.8	186.3	2.7	2.5	2.7
			2.32e+00	2.81e-01	3.31e-02	3.31e-02	4.01e-03	9.7	60.4	0.9	0.8	0.9
			2.74e+00	3.32e-01	3.92e-02	3.92e-02	4.75e-03	8.2	51.1	0.7	0.7	0.7
			1.78e+00	2.15e-01	2.54e-02	2.54e-02	3.08e-03	12.6	78.8	1.1	1.0	1.1
			5.48e+00	6.65e-01	7.83e-02	7.83e-02	9.49e-03	4.1	25.5	0.4	0.3	0.4
		Sugar Beets	8.88e-01	1.08e-01	1.27e-02	1.27e-02	1.54e-03	25.2	157.7	2.3	2.1	2.2
			2.52e+00	3.06e-01	3.60e-02	3.60e-02	4.37e-03	8.9	55.5	0.8	0.7	0.8
			4.13e+00	5.01e-01	5.90e-02	5.90e-02	7.16e-03	5.4	33.9	0.5	0.4	0.5
		Sorghum	8.88e-01	1.08e-01	1.27e-02	1.27e-02	1.54e-03	25.2	157.7	2.3	2.1	2.2
			2.52e+00	3.06e-01	3.60e-02	3.60e-02	4.37e-03	8.9	55.5	0.8	0.7	0.8
4.13e+00	5.01e-01		5.90e-02	5.90e-02	7.16e-03	5.4	33.9	0.5	0.4	0.5		

APPENDIX A/TABLE 8: TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS AT THE MINIMUM PERSONAL PROTECTION LEVEL USING PHED DATA												
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DAILY EXPOSURE		DAILY DOSE			DERMAL MOEs		INHAL. MOE	COMBINED MOE	
			DERMAL (mg/day)	INHALAT. (mg/day)	15 G DERMAL (mg/kg/day)	20 CR DERMAL (mg/kg/day)	INHAL. (mg/kg/day)	15 G	20 CR		15 G	20 CR
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	5.24e-01	2.58e-02	7.48e-03	7.48e-03	3.69e-04	42.8	267.3	9.5	7.8	9.2
			1.61e+00	7.96e-02	2.31e-02	2.31e-02	1.14e-03	13.9	86.7	3.1	2.5	3.0
			1.91e+00	9.41e-02	2.73e-02	2.73e-02	1.34e-03	11.7	73.3	2.6	2.1	2.5
			1.24e+00	6.10e-02	1.77e-02	1.77e-02	8.71e-04	18.1	113.1	4.0	3.3	3.9
			3.82e+00	1.88e-01	5.46e-02	5.46e-02	2.69e-03	5.9	36.6	1.3	1.1	1.3
		Sugar Beets	6.19e-01	3.05e-02	8.84e-03	8.84e-03	4.36e-04	36.2	226.2	8.0	6.6	7.8
			1.76e+00	8.66e-02	2.51e-02	2.51e-02	1.24e-03	12.7	79.6	2.8	2.3	2.7
			2.88e+00	1.42e-01	4.12e-02	4.12e-02	2.03e-03	7.8	48.6	1.7	1.4	1.7
		Sorghum	6.19e-01	3.05e-02	8.84e-03	8.84e-03	4.36e-04	36.2	226.2	8.0	6.6	7.8
			1.76e+00	8.66e-02	2.51e-02	2.51e-02	1.24e-03	12.7	79.6	2.8	2.3	2.7
			2.88e+00	1.42e-01	4.12e-02	4.12e-02	2.03e-03	7.8	48.6	1.7	1.4	1.7
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	5.46e-01	1.82e-02	7.81e-03	7.81e-03	2.60e-04	41.0	256.2	13.5	10.1	12.8
			1.68e+00	5.62e-02	2.41e-02	2.41e-02	8.02e-04	13.3	83.1	4.4	3.3	4.1
			1.99e+00	6.65e-02	2.85e-02	2.85e-02	9.49e-04	11.2	70.2	3.7	2.8	3.5
			1.29e+00	4.31e-02	1.85e-02	1.85e-02	6.15e-04	17.3	108.4	5.7	4.3	5.4
			3.99e+00	1.33e-01	5.70e-02	5.70e-02	1.90e-03	5.6	35.1	1.8	1.4	1.8
		Sugar Beets	6.46e-01	2.15e-02	9.23e-03	9.23e-03	3.08e-04	34.7	216.8	11.4	8.6	10.8
			1.83e+00	6.12e-02	2.62e-02	2.62e-02	8.74e-04	12.2	76.3	4.0	3.0	3.8
			3.01e+00	1.00e-01	4.29e-02	4.29e-02	1.43e-03	7.5	46.6	2.4	1.8	2.3
		Sorghum	6.46e-01	2.15e-02	9.23e-03	9.23e-03	3.08e-04	34.7	216.8	11.4	8.6	10.8
			1.83e+00	6.12e-02	2.62e-02	2.62e-02	8.74e-04	12.2	76.3	4.0	3.0	3.8
			3.01e+00	1.00e-01	4.29e-02	4.29e-02	1.43e-03	7.5	46.6	2.4	1.8	2.3

APPENDIX A/TABLE 9: TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS AT THE MAXIMUM PERSONAL PROTECTION LEVEL USING PHED DATA												
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DAILY EXPOSURE		DAILY DOSE			DERMAL MOEs		INHAL. MOE	COMBINED MOE	
			DERMAL (mg/day)	INHALAT. (mg/day)	15 G DERMAL (mg/kg/day)	20 CR DERMAL (mg/kg/day)	INHAL. (mg/kg/day)	15 G	20 CR		15 G	20 CR
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	2.58e-01	1.29e-02	3.69e-03	3.69e-03	1.84e-04	86.8	542.5	19.0	15.6	18.3
			7.96e-01	3.98e-02	1.14e-02	1.14e-02	5.68e-04	28.2	176.0	6.2	5.1	6.0
			9.41e-01	4.71e-02	1.34e-02	1.34e-02	6.72e-04	23.8	148.7	5.2	4.3	5.0
			6.10e-01	3.05e-02	8.71e-03	8.71e-03	4.36e-04	36.7	229.5	8.0	6.6	7.8
			1.88e+00	9.41e-02	2.69e-02	2.69e-02	1.34e-03	11.9	74.4	2.6	2.1	2.5
		Sugar Beets	3.05e-01	1.52e-02	4.36e-03	4.36e-03	2.18e-04	73.4	459.0	16.1	13.2	15.5
			8.66e-01	4.33e-02	1.24e-02	1.24e-02	6.19e-04	25.9	161.6	5.7	4.6	5.5
			1.42e+00	7.10e-02	2.03e-02	2.03e-02	1.01e-03	15.8	98.6	3.5	2.8	3.3
		Sorghum	3.05e-01	1.52e-02	4.36e-03	4.36e-03	2.18e-04	73.4	459.0	16.1	13.2	15.5
			8.66e-01	4.33e-02	1.24e-02	1.24e-02	6.19e-04	25.9	161.6	5.7	4.6	5.5
			1.42e+00	7.10e-02	2.03e-02	2.03e-02	1.01e-03	15.8	98.6	3.5	2.8	3.3
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	3.19e-01	9.11e-03	4.55e-03	4.55e-03	1.30e-04	70.3	439.2	26.9	19.5	25.3
			9.83e-01	2.81e-02	1.40e-02	1.40e-02	4.01e-04	22.8	142.5	8.7	6.3	8.2
			1.16e+00	3.32e-02	1.66e-02	1.66e-02	4.75e-04	19.3	120.4	7.4	5.3	6.9
			7.53e-01	2.15e-02	1.08e-02	1.08e-02	3.08e-04	29.7	185.8	11.4	8.2	10.7
			2.33e+00	6.65e-02	3.32e-02	3.32e-02	9.49e-04	9.6	60.2	3.7	2.7	3.5
		Sugar Beets	3.77e-01	1.08e-02	5.38e-03	5.38e-03	1.54e-04	59.5	371.6	22.8	16.5	21.4
			1.07e+00	3.06e-02	1.53e-02	1.53e-02	4.37e-04	20.9	130.8	8.0	5.8	7.6
			1.75e+00	5.01e-02	2.50e-02	2.50e-02	7.16e-04	12.8	79.8	4.9	3.5	4.6
		Sorghum	3.77e-01	1.08e-02	5.38e-03	5.38e-03	1.54e-04	59.5	371.6	22.8	16.5	21.4
			1.07e+00	3.06e-02	1.53e-02	1.53e-02	4.37e-04	20.9	130.8	8.0	5.8	7.6
			1.75e+00	5.01e-02	2.50e-02	2.50e-02	7.16e-04	12.8	79.8	4.9	3.5	4.6

APPENDIX A/TABLE 10: TERBUFOS OCCUPATIONAL HANDLER EXPOSURE AND RISK CALCULATIONS WITH ENGINEERING CONTROL LEVEL PERSONAL PROTECTION USING PHED DATA												
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	DAILY EXPOSURE		DAILY DOSE			DERMAL MOEs		INHAL. MOE	COMBINED MOE	
			DERMAL (mg/day)	INHALAT. (mg/day)	15 G DERMAL (mg/kg/day)	20 CR DERMAL (mg/kg/day)	INHAL. (mg/kg/day)	15 G	20 CR		15 G	20 CR
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	1.28e-02	2.58e-03	1.82e-04	1.82e-04	3.69e-05	1756.7	10979.4	94.9	90.1	94.1
			3.93e-02	7.96e-03	5.62e-04	5.62e-04	1.14e-04	569.8	3561.3	30.8	29.2	30.5
			4.65e-02	9.41e-03	6.65e-04	6.65e-04	1.34e-04	481.5	3009.5	26.0	24.7	25.8
			3.01e-02	6.10e-03	4.31e-04	4.31e-04	8.71e-05	743.2	4645.1	40.2	38.1	39.8
			9.30e-02	1.88e-02	1.33e-03	1.33e-03	2.69e-04	240.8	1504.8	13.0	12.3	12.9
		Sugar Beets	1.51e-02	3.05e-03	2.15e-04	2.15e-04	4.36e-05	1486.4	9290.2	80.3	76.2	79.6
			4.28e-02	8.66e-03	6.12e-04	6.12e-04	1.24e-04	523.3	3270.5	28.3	26.8	28.0
			7.01e-02	1.42e-02	1.00e-03	1.00e-03	2.03e-04	319.4	1996.1	17.3	16.4	17.1
		Sorghum	1.51e-02	3.05e-03	2.15e-04	2.15e-04	4.36e-05	1486.4	9290.2	80.3	76.2	79.6
			4.28e-02	8.66e-03	6.12e-04	6.12e-04	1.24e-04	523.3	3270.5	28.3	26.8	28.0
			7.01e-02	1.42e-02	1.00e-03	1.00e-03	2.03e-04	319.4	1996.1	17.3	16.4	17.1
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	1.59e-01	1.67e-02	2.28e-03	2.28e-03	2.39e-04	140.5	878.3	14.7	13.3	14.4
			4.91e-01	5.15e-02	7.02e-03	7.02e-03	7.36e-04	45.6	284.9	4.8	4.3	4.7
			5.81e-01	6.09e-02	8.31e-03	8.31e-03	8.71e-04	38.5	240.8	4.0	3.6	4.0
			3.77e-01	3.95e-02	5.38e-03	5.38e-03	5.64e-04	59.5	371.6	6.2	5.6	6.1
			1.16e+00	1.22e-01	1.66e-02	1.66e-02	1.74e-03	19.3	120.4	2.0	1.8	2.0
		Sugar Beets	1.88e-01	1.97e-02	2.69e-03	2.69e-03	2.82e-04	118.9	743.2	12.4	11.2	12.2
			5.35e-01	5.61e-02	7.64e-03	7.64e-03	8.01e-04	41.9	261.6	4.4	4.0	4.3
			8.77e-01	9.19e-02	1.25e-02	1.25e-02	1.31e-03	25.6	159.7	2.7	2.4	2.6
		Sorghum	1.88e-01	1.97e-02	2.69e-03	2.69e-03	2.82e-04	118.9	743.2	12.4	11.2	12.2
			5.35e-01	5.61e-02	7.64e-03	7.64e-03	8.01e-04	41.9	261.6	4.4	4.0	4.3
			8.77e-01	9.19e-02	1.25e-02	1.25e-02	1.31e-03	25.6	159.7	2.7	2.4	2.6

APPENDIX A/TABLE 11: TERBUFOS MOEs ATTRIBUTABLE TO OCCUPATIONAL DERMAL EXPOSURE USING PHED DATA												
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	EXPOSURE FACTORS		15 G DERMAL MOEs FOR VARIED PROTECTION				20 CR DERMAL MOEs FOR VARIED PROTECTION			
			RATE	ACRES OR GALLONS	BASELINE	MINIMUM PPE (SINGLE LAYER & GLOVES)	MAXIMUM PPE (DOUBLE LAYER & GLOVES)	ENG. CONTROL S	BASELINE	MINIMUM PPE (SINGLE LAYER & GLOVES)	MAXIMUM PPE (DOUBLE LAYER & GLOVES)	ENG. CONTROLS
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	1.1	69	35.1	42.8	86.8	1756.7	219.6	267.3	542.5	10979.4
			1.3	180	11.4	13.9	28.2	569.8	71.2	86.7	176.0	3561.3
			1.3	213	9.6	11.7	23.8	481.5	60.2	73.3	148.7	3009.5
			2.6	69	14.9	18.1	36.7	743.2	92.9	113.1	229.5	4645.1
			2.6	213	4.8	5.9	11.9	240.8	30.1	36.6	74.4	1504.8
		Sugar Beets	1.3	69	29.7	36.2	73.4	1486.4	185.8	226.2	459.0	9290.2
			1.96	130	10.5	12.7	25.9	523.3	65.4	79.6	161.6	3270.5
			1.96	213	6.4	7.8	15.8	319.4	39.9	48.6	98.6	1996.1
		Sorghum	1.3	69	29.7	36.2	73.4	1486.4	185.8	226.2	459.0	9290.2
			1.96	130	10.5	12.7	25.9	523.3	65.4	79.6	161.6	3270.5
			1.96	213	6.4	7.8	15.8	319.4	39.9	48.6	98.6	1996.1
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	1.1	69	29.8	41.0	70.3	140.5	186.3	256.2	439.2	878.3
			1.3	180	9.7	13.3	22.8	45.6	60.4	83.1	142.5	284.9
			1.3	213	8.2	11.2	19.3	38.5	51.1	70.2	120.4	240.8
			2.6	69	12.6	17.3	29.7	59.5	78.8	108.4	185.8	371.6
			2.6	213	4.1	5.6	9.6	19.3	25.5	35.1	60.2	120.4
		Sugar Beets	1.3	69	25.2	34.7	59.5	118.9	157.7	216.8	371.6	743.2
			1.96	130	8.9	12.2	20.9	41.9	55.5	76.3	130.8	261.6
			1.96	213	5.4	7.5	12.8	25.6	33.9	46.6	79.8	159.7
		Sorghum	1.3	69	25.2	34.7	59.5	118.9	157.7	216.8	371.6	743.2
			1.96	130	8.9	12.2	20.9	41.9	55.5	76.3	130.8	261.6
			1.96	213	5.4	7.5	12.8	25.6	33.9	46.6	79.8	159.7

APPENDIX A/TABLE 12: TERBUFOS MOEs ATTRIBUTABLE TO OCCUPATIONAL INHALATION EXPOSURE USING PHED DATA								
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	EXPOSURE FACTORS		INHALATION MOEs FOR VARIED PROTECTION			
			RATE	ACRES OR GALLONS	BASELINE	MINIMUM PPE PF 5 Respirator	MAXIMUM PPE PF 10 Respirator	ENG. CONTROLS
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	1.1	69	1.9	9.5	19.0	94.9
			1.3	180	0.6	3.1	6.2	30.8
			1.3	213	0.5	2.6	5.2	26.0
			2.6	69	0.8	4.0	8.0	40.2
			2.6	213	0.3	1.3	2.6	13.0
		Sugar Beets	1.3	69	1.6	8.0	16.1	80.3
			1.96	130	0.6	2.8	5.7	28.3
			1.96	213	0.3	1.7	3.5	17.3
		Sorghum	1.3	69	1.6	8.0	16.1	80.3
			1.96	130	0.6	2.8	5.7	28.3
			1.96	213	0.3	1.7	3.5	17.3
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	1.1	69	2.7	13.4	26.9	14.7
			1.3	180	0.9	4.4	8.7	4.8
			1.3	213	0.7	3.7	7.4	4.0
			2.6	69	1.1	5.7	11.4	6.2
			2.6	213	0.4	1.8	3.7	2.0
		Sugar Beets	1.3	69	2.3	11.4	22.8	12.4
			1.96	130	0.8	4.0	8.0	4.4
			1.96	213	0.5	2.4	4.9	2.7
		Sorghum	1.3	69	2.3	11.4	22.8	12.4
			1.96	130	0.8	4.0	8.0	4.4
			1.96	213	0.5	2.4	4.9	2.7

APPENDIX A/TABLE 13: TERBUFOS MOEs ATTRIBUTABLE TO COMBINED OCCUPATIONAL DERMAL AND INHALATION EXPOSURES TO THE 15 G FORMULATION												
SCEN	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	EXPOSURE FACTORS		SUMMARY MOEs FOR COMBINATIONS OF DERMAL AND INHALATION PROTECTIVE MEASURES							
			RATE	ACRES OR GALLONS	BASELINE (TABLE 7)	SINGLE LAYER, GLOVES & NO RESPIRATOR (TABLES 7&8)	SINGLE LAYER, GLOVES & PF 5 RESPIRATOR (TABLE 8)	SINGLE LAYER, GLOVES & PF 10 RESPIRATOR (TABLES 8&9)	DOUBLE LAYER, GLOVES & NO RESPIRATOR (TABLES 8&9)	DOUBLE LAYER, GLOVES & PF 5 RESPIRATOR (TABLES 8&9)	DOUBLE LAYER, GLOVES & PF 10 RESPIRATOR (TABLE 9)	ENG. CONTROLS (TABLE 10)
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	1.1	69	1.8	1.8	7.8	13.2	1.9	8.6	15.6	90.1
			1.3	180	0.6	0.6	2.5	4.3	0.6	2.8	5.1	29.2
			1.3	213	0.5	0.5	2.1	3.6	0.5	2.3	4.3	24.7
			2.6	69	0.8	0.8	3.3	5.6	0.8	3.6	6.6	38.1
			2.6	213	0.2	0.2	1.1	1.8	0.3	1.2	2.1	12.3
		Sugar Beets	1.3	69	1.5	1.5	6.6	11.1	1.6	7.2	13.2	76.2
			1.96	130	0.5	0.5	2.3	3.9	0.6	2.5	4.6	26.8
			1.96	213	0.3	0.3	1.4	2.4	0.3	1.6	2.8	16.4
		Sorghum	1.3	69	1.5	1.5	6.6	11.1	1.6	7.2	13.2	76.2
			1.96	130	0.5	0.5	2.3	3.9	0.6	2.5	4.6	26.8
			1.96	213	0.3	0.3	1.4	2.4	0.3	1.6	2.8	16.4
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	1.1	69	2.5	2.5	10.1	16.2	2.6	11.3	19.5	13.3
			1.3	180	0.8	0.8	3.3	5.3	0.8	3.7	6.3	4.3
			1.3	213	0.7	0.7	2.8	4.5	0.7	3.1	5.3	3.6
			2.6	69	1.0	1.1	4.3	6.9	1.1	4.8	8.2	5.6
			2.6	213	0.3	0.3	1.4	2.2	0.4	1.5	2.7	1.8
		Sugar Beets	1.3	69	2.1	2.1	8.6	13.7	2.2	9.6	16.5	11.2
			1.96	130	0.7	0.8	3.0	4.8	0.8	3.4	5.8	4.0
			1.96	213	0.4	0.5	1.8	3.0	0.5	2.1	3.5	2.4
		Sorghum	1.3	69	2.1	2.1	8.6	13.7	2.2	9.6	16.5	11.2
			1.96	130	0.7	0.8	3.0	4.8	0.8	3.4	5.8	4.0
			1.96	213	0.4	0.5	1.8	3.0	0.5	2.1	3.5	2.4

APPENDIX A/TABLE 14: TERBUFOS MOEs ATTRIBUTABLE TO COMBINED OCCUPATIONAL DERMAL AND INHALATION EXPOSURES TO THE 20 CR FORMULATION												
SCEN.	SCEN. DESCRIPTOR	CROP TYPE OR TARGET	EXPOSURE FACTORS		SUMMARY MOEs FOR COMBINATIONS OF DERMAL AND INHALATION PROTECTIVE MEASURES							
			RATE	ACRES	BASELINE (TABLE 7)	SINGLE LAYER, GLOVES & NO RESPIRATOR (TABLES 7&8)	SINGLE LAYER, GLOVES & PF 5 RESPIRATOR (TABLE 8)	SINGLE LAYER, GLOVES & PF 10 RESPIRATOR (TABLES 8&9)	DOUBLE LAYER, GLOVES & NO RESPIRATOR (TABLES 8&9)	DOUBLE LAYER, GLOVES & PF 5 RESPIRATOR (TABLES 8&9)	DOUBLE LAYER, GLOVES & PF 10 RESPIRATOR (TABLE 9)	ENG. CONTROLS (TABLE 10)
1a	Loading of Granular Formulations (Using PHED data for clay-based granules)	Corn	1.1	69	1.9	1.9	9.2	17.7	1.9	9.3	18.3	94.1
			1.3	180	0.6	0.6	3.0	5.8	0.6	3.0	6.0	30.5
			1.3	213	0.5	0.5	2.5	4.9	0.5	2.6	5.0	25.8
			2.6	69	0.8	0.8	3.9	7.5	0.8	3.9	7.8	39.8
			2.6	213	0.3	0.3	1.3	2.4	0.3	1.3	2.5	12.9
		Sugar Beets	1.3	69	1.6	1.6	7.8	15.0	1.6	7.9	15.5	79.6
			1.96	130	0.6	0.6	2.7	5.3	0.6	2.8	5.5	28.0
			1.96	213	0.3	0.3	1.7	3.2	0.3	1.7	3.3	17.1
		Sorghum	1.3	69	1.6	1.6	7.8	15.0	1.6	7.9	15.5	79.6
			1.96	130	0.6	0.6	2.7	5.3	0.6	2.8	5.5	28.0
			1.96	213	0.3	0.3	1.7	3.2	0.3	1.7	3.3	17.1
2a	Applying Granular Formulations With Ground-Based Equipment (Using PHED data for clay-based granules)	Corn	1.1	69	2.7	2.7	12.8	24.3	2.7	13.1	25.3	14.4
			1.3	180	0.9	0.9	4.1	7.9	0.9	4.2	8.2	4.7
			1.3	213	0.7	0.7	3.5	6.7	0.7	3.6	6.9	4.0
			2.6	69	1.1	1.1	5.4	10.3	1.1	5.5	10.7	6.1
			2.6	213	0.4	0.4	1.8	3.3	0.4	1.8	3.5	2.0
		Sugar Beets	1.3	69	2.2	2.3	10.8	20.6	2.3	11.0	21.4	12.2
			1.96	130	0.8	0.8	3.8	7.3	0.8	3.9	7.6	4.3
			1.96	213	0.5	0.5	2.3	4.4	0.5	2.4	4.6	2.6
		Sorghum	1.3	69	2.2	2.3	10.8	20.6	2.3	11.0	21.4	12.2
			1.96	130	0.8	0.8	3.8	7.3	0.8	3.9	7.6	4.3
			1.96	213	0.5	0.5	2.3	4.4	0.5	2.4	4.6	2.6